NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

GUIDE FOR DEVELOPING A STATE TRANSPORTATION RESEARCH MANUAL

APRIL 1997

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April 1997

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MANUAL FOR TRANSPORTATION RESEARCH FOR THE STATE OF [fill in State name]

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INTRODUCTION

Background

The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 led the Federal Highway Administration (FHWA) to institute rulemaking changes that made individual states more autonomous and also more accountable for their research programs. ISTEA also mandated that a minimum of 25 percent of the State Planning and Research (SPR) funds be spent on research, development, and technology transfer (RD&T) activities.

While the FHWA rulemaking is undoubtedly beneficial, in that it empowers states to deal with their own issues, it does require that the states certify that their research programs conform to a pre-approved management process. Code of Federal Register (CFR) Section 420.207 of 23, final rule effective August 22, 1994, further requires the states to develop, establish, and implement a management process that identifies and implements RD&T activities expected to address priority transportation issues and includes the following:

1. An interactive process for identification and prioritization of RD&T activities for inclusion in an RD&T work program;
2. Utilization, to the maximum extent possible, of all FHWA planning and research funds set aside for RD&T activities either internally or for participation in national, regional pooled, or cooperatively funded studies;
3. Procedures for tracking program activities, schedules, accomplishments, and fiscal commitments;
4. Support and use of the Transportation Research Information System (TRIS) database for program development, reporting active RD&T activities, and inputing the final report information;
5. Procedures to determine the effectiveness of the state's management process in implementing the RD&T program, to determine the utilization of the state's RD&T outputs, and to facilitate peer reviews of its RD&T on a periodic basis; and
6. Procedures for documenting RD&T activities through the preparation of final reports. As a minimum, the documentation shall include the data collected, analyses performed, conclusions and recommendations. The states shall actively implement appropriate research findings and should document benefits.

Purpose of the Guide

At the time of ISTEA, many states had no formal process. In addition to the certification process, the increase in SPR funding—which resulted in an enormous increase in many state research programs— has led to greater management demands on the research staff. In response to this and at the request of the states, the National Cooperative Highway Research Program (NCHRP) developed this guide. The guide responds to the requirements of the FHWA rule—23 CFR, Part 420, State Planning and Research, Subpart B, and is for states to use in developing procedures and processes to meet the requirements. The guide goes beyond the requirements of the FHWA regulations. All aspects of the functioning of a research unit are in it, including planning, project and program development and evaluation, resource and project management, administrative matters, technology transfer and organization.

The guide is intended to assist states in developing or modifying their transportation research manuals. Each section of the suggested text, which the state may use in developing its manual, contains explanatory information in italics (commentary). The attached diskette contains an electronic version of this document in WordPerfect 5.1 format for ease of extracting appropriate text.

MANUAL FOR TRANSPORTATION RESEARCH

FOR THE STATE OF [fill in State name]

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APPENDIX A-1

SECTION 1.0 PURPOSE AND CONTEXT OF MANUAL

1.1 Background

Research, one of the principal missions of the first national highway program in the United States is, the oldest continuous federal highway activity. The Federal Highway Act of 1921 authorized the first sustained fiscal support for highway research. Support for highway research was reaffirmed in the Federal-Aid Highway Act of 1962, which mandated funds for planning and research purposes only. Most recently, the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 required that a minimum of 25 percent of the State Planning and Research (SPR) funds shall be expended on research, development and technology transfer activities.

> *COMMENTARY:*
> *The FHWA's RD&T Program Manual gives a more expanded history of transportation research. Users are advised to refer to this manual if they wish to expand on the above text. In addition, it may be useful to include a history of research in the state in this section of the guide.*

1.2 Purpose

The research unit exists to benefit the Agency, its employees, and other transportation agency users. The purpose of this manual is to improve the effectiveness of research by identifying research unit functions and procedures.

This manual provides guidance on the following:

- Determining the usefulness and implementation potential of the research,
- Ensuring that short-term research results are incorporated in a long-term program,
- Assessing research using project and program accomplishments,
- Improving research through the coordination of several disciplines, and
- Determining the continuation potential of a research project based on a periodic review of its progress.

1.3 Authority

The authority for the State research organization to use federal funds is found in 23 United States Code 307(c). The authority for the State to administer the SPR funds in the program is found in 23 Code of Federal Register 420, Subpart B.

> *COMMENTARY:*
> *Besides the federal citations, all appropriate state citations should be included. These may include state legislation and university*

agreements and references to department administrative manuals, etc.

1.4 Overview of the Manual

The research management manual covers the complete process used by the research unit, from program development through program evaluation, including technology transfer and the management requirements needed to maintain an effective research program. A flow chart of the process (Figure 1) represents all of the activities performed by the research unit.

COMMENTARY:
An overview subsection to the manual gives the reader an expanded table of contents. The manual could benefit from expanding the description of the individual sections. It may make it easier to find those sections that are of interest. Sometimes the overlap of sections could have the reader hunting for the desired section.

The first section (Purpose and Context of Manual) defines the need for a manual. The manual gives an organized process and solid management principles that will help managers and staff improve their research program.

The second section (Goals and Policies) discusses the Agency's goals and how they reflect on those of research. Particular attention is given to the need for and development of strategic plans. Details are also given of the options for customer support processes, as they are used to increase the interactive nature of the research program.

The third section (RD&T Organization) discusses the structural organization of research both within the unit and within the Agency. Definition is given to the structure and research interactive role of the many committees that could form customer support.

The fourth section (Program Development) details the process for the development of the work program. It includes the solicitation process beginning with developing a problem statement request to the screening efforts conducted by the research staff and review by the Research Advisory Committee on the problem lists. A review and prioritization of the problem statements leads to the formation of the work program. A descriptive narrative is also given of the elements of the work program.

The fifth section (Project Development) describes the components of a project work plan including suggestions for involving the Agency's operating units. Details of the elements of staff and contract research are specified, including the solicitation, selection and negotiations processes.

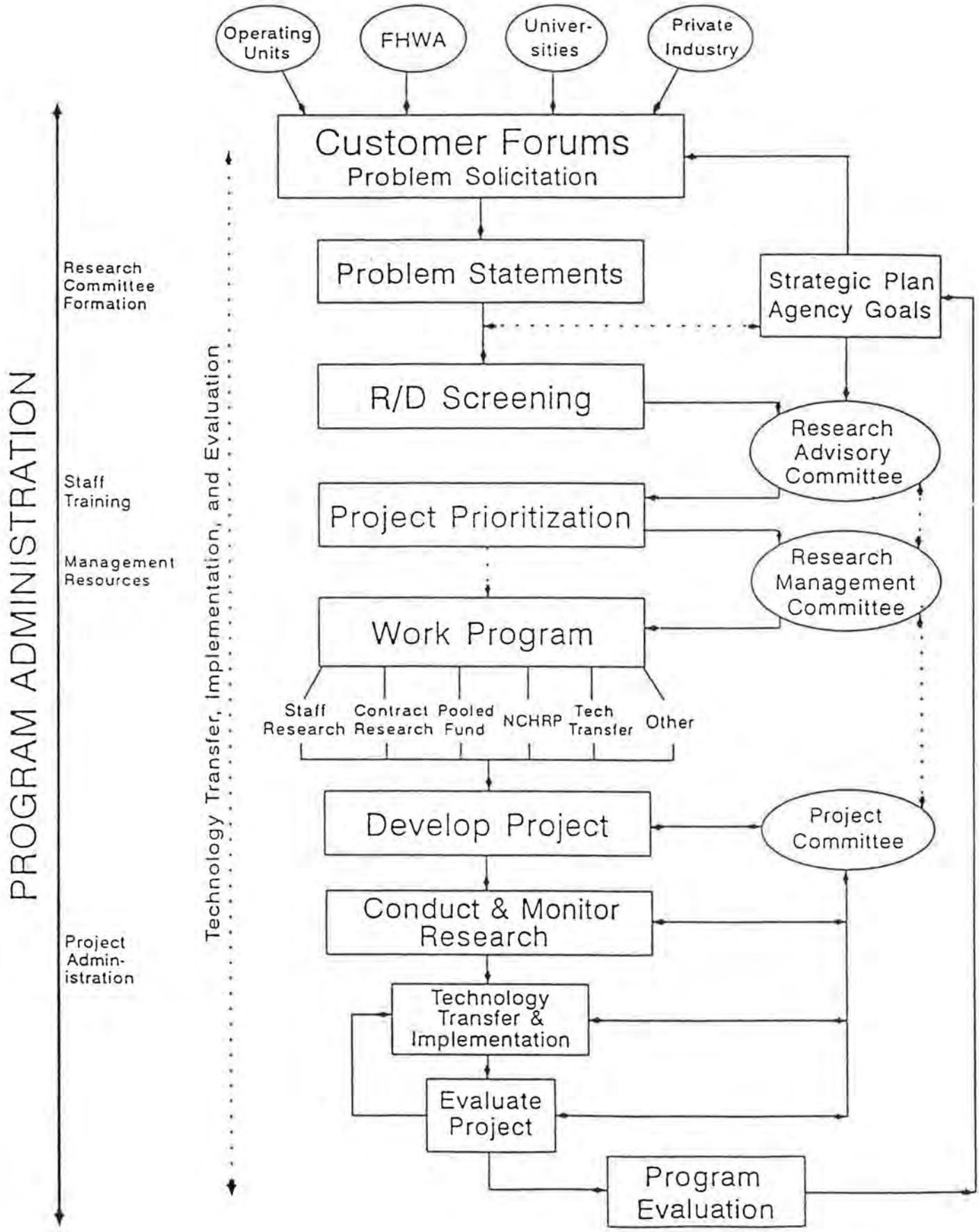

Figure 1. Research Management Process

The sixth section (Conducting and Monitoring Research Projects) contains a discussion of the daily routine of research staff. Particular detail is given to monitoring contracts.

The seventh section (Program Reporting) describes the elements to report on the project and program levels. The elements include technical and financial information and report frequency.

The eighth section (Technology Transfer) starts with an outline of one of the most important activities in the research process. This is followed by details on pursuing information sources, reviewing literature, forming instructional sessions and providing expert advice and support.

The ninth section (Implementation Process) defines an implementation process and offers suggestions on facilitating the process through improved monitoring and interactive techniques.

The tenth section (Project Final Evaluation) defines methods of evaluating projects from the Agency perspective and the nondepartmental view. Different methods of economic analyses are suggested to determine the benefits of the research and its implementation.

The eleventh section (Program Evaluation) offers evaluation techniques ranging from the work program achievement level through the implementation and economic benefit efforts to the on-site peer review. The peer exchange evaluation offers interaction and feedback that cannot be attained through the other methods.

The twelfth section (Program Management) outlines a comprehensive staff training program, suggestions for resources necessary to maintain national professional contacts, administrative issues, the work program process and liability concerns.

SECTION 2.0 GOALS AND POLICIES

2.1 Goals and Policy of the Agency

The goals of the Agency define the anticipated levels of achievement and the expected results of the effort expended by its employees. The Agency's well-crafted goals are guiding principles by which it functions.

In addition, the Agency has a mission statement that succinctly defines the reason for its existence. Mission and goals are designed to be understood by employees and customers alike. Goals are broad and encompassing, yet provide focus for the Agency to accomplish its mission and enable employees to work toward the same goals, regardless of what the individual assignment may be. The goals are tied to functional responsibility, assisting in defining the organizational structure of the Agency.

Policies are the documented courses of action which, when adopted, enable or direct personnel to reach the defined goals or accomplish the stated mission. Policies describe the means, process, or expected standard of practice by which the Agency operates.

The mission statement of the Agency and its goals and policies are available in the research manager's office.

COMMENTARY:

The research manual should make reference to or include agency goals and policies affecting the RD&T activities. Referencing them can be more practical than including them, particularly if the goals and policies change with administrations. Their presence along with the research unit's goals and policies will show the integration of RD&T activities with overall agency operations. Furthermore, incorporating in the research manual a clear reference to the most critical policies will make it easier for research personnel to maintain agency standards of operation.

Generally the goals or objectives and mission of most agencies are established, and copies of these statements can be procured by the research unit. All of these declarations are a means of defining what the agency does and why it is in business. Quite often these statements are clearly displayed in agency offices or appear with agency logos or on business cards. Research unit management may have an opportunity to give input to the agency's goals. Should such an opportunity occur, incorporating research and innovation into an agency's goals is very desirable.

It is critical for the research unit to understand and work toward accomplishing agency goals. Foremost, the research unit's goals should support the overall agency goals. (See Section 2.2.) In addition, the research unit, as all other agency units, is valuable to the organization if it contributes to the agency goals and assists in accomplishing the agency's mission.

2.2 Mission, Goals, and Policy of Research, Development, and Technology

2.2.1 Mission

The mission statement expresses the reason for the research unit's existence. The mission statement assists the unit employees to better understand their role. Additionally, because there are others in the Agency who may not fully understand the research function or its contribution, a clear, easily understood, and well-publicized mission statement is informative to other Agency personnel. The mission statement articulates the "business" of RD&T in an appropriate manner, using the terminology of the research unit.

COMMENTARY:
The research unit's mission statement should be inserted in the manual after the above paragraph.
Mission statements are concise—generally no longer than one paragraph. These statements can be used in a variety of contexts, such as brochures, reports, and other items produced by the research unit.
It is imperative that the research unit mission be in concert with and fully support the agency mission. It is desirable for the RD&T mission statement to reflect its support of the agency mission directly by the terminology of the statement. A well-worded mission statement shows that the research function is an integral part of the agency.
Preparing a mission statement is a worthwhile endeavor for the unit's staff because it gives the research unit an opportunity to think through and express its purpose. For research units that have a mission statement in place, an occasional review is appropriate. A research unit should always have a current mission statement. A mission statement should be done whether or not the agency requires it.
A mission statement provides a solid marketing tool for customer education. Having a succinct statement of what the research unit does and why it exists will be helpful to those in the agency who need research work performed or for those who will ultimately implement research results.
Examples of research unit missions are as follows:

- *The primary mission of the research unit is to improve the transportation system in the state by conducting research, disseminating information, and assisting state and local transportation agencies.*

- *The research unit shall perform tests; perform research; inspect and test all materials, supplies, equipment, and machinery used for state highway purposes or on highway projects involving federal funds; and develop procedures for this purpose.*
- *The research unit shall support the scientific approach to highway and transportation system engineering for the state by securing and disseminating information vital to this approach.*
- *The research unit shall provide materials and geotechnical engineering services and targeted engineering research in a timely and cost-effective manner for the department and other governmental agencies; develop and recommend engineering policies, standards, and specifications; manage a quality assurance program for materials incorporated into department projects; and conduct specialized engineering studies requiring investigations, testing, analysis, and recommendations.*
- *The research unit shall make investigations to place at the service of the state the most approved methods of highway construction, improvement, and maintenance. The research unit shall also determine the methods of highway construction, improvement, and maintenance best adapted to the various sections of the state and the best methods of construction, improvement, and maintenance of highways by making experiments in relation thereto from time to time.*

2.2.2 Goals

The goals of the research unit assist in defining the levels of achievement or expected results of staff efforts. The goals address current priorities of both the unit and the Agency.

Research goals are directed toward fulfilling the goals of the Agency and are entirely compatible with them. Such goals show that the research unit is part of the team to accomplish the Agency's mission. Unique RD&T goals allow the research unit to prioritize activities. Goals also contain an adequate level of detail so that the anticipated level of performance specified in the goal can be compared to the actual performance.

Staff members shall post the unit's current goals at their work station.

COMMENTARY:
Goals are clear and succinct and preferably short (one or two sentences). Most importantly, goals are achievable. While broad and encompassing the complex business of the whole research unit, each goal is focused and generally deals with only one item for

achievement. Some goals may change regularly and others may continue as stated for many years.

The time frame for accomplishing the goals can be whatever is appropriate. What is important is that at some future time, the research unit can show performance based on some previously set standard. It is appropriate for the research unit to have goals, particularly if this is a requirement of other units within the Agency.

Setting research unit goals that support the Agency's overall goals show that the research unit is truly "contributing its share." In times of tight fiscal budgets and cutbacks in programs, it is particularly critical for research units to have a means to measure their contribution to the Agency's overall effort.

Although it is important to integrate the research unit's goals with the agency goals, care must be taken 1) that the research unit's goals stand on their own merit and 2) that the goals are not totally dependent on another unit's performance. The research unit should generally control the activities that are critical to achieving its goals.

As with a mission statement, goals can be marketing tools, especially for internal agency customers.

Examples of research unit goals are as follows:

- *Perform and promote transportation-related research and support activities.*
- *Use Total Quality Management to ensure that our products and services are always of the highest quality.*
- *Promote effective communication with all our customers.*
- *Promote and ensure a high level of staff skills, productivity, and satisfaction.*
- *Evaluate and assess materials and processes used in the construction and maintenance of asphalt pavements and surface treated roads.*
- *Evaluate and apply non-destructive test procedures for the assessment of the integrity and inspection of our pavements and structures.*
- *Assist the department with the development of technology to protect and enhance the physical environment with respect to roadside vegetation, wetlands, scour, and highway runoff.*
- *Support the development and implementation of pavement and bridge management systems and implementation of a geographical information system to enhance the maintenance of the state's transportation system.*

2.2.3 Policy

The research unit's policies and procedures are detailed in the Agency's administrative directives and policy manuals.

The policy development effort is an important exercise for the research unit because Agency endorsement of the policy brings visibility and approval from top management. Furthermore, there will be periodic review of the policies relating to RD&T processes. New policy development or a review process of existing policies allows Agency management opportunity to include priority responsibilities and other items of current importance. The effort to be continuously relevant is significant, because research activities, even when addressing critical needs, are sometimes seen as being apart from the Agency's day-to-day business. RD&T policies focus on the creation and scope of the research function, on the composition and responsibilities of research committees, and on product evaluation, implementation, and technology transfer procedures.

COMMENTARY:

If an agency has not yet developed an RD&T policy, it is desirable to do so. The actual names for the directives and manuals should be given.

An agency often may have one or more policy statements defining its research unit or activities relating to research. Such policies define authority, research processes, funding options, and resources assigned and/or provide other functional guidance or material for operational practice. RD&T policies are not a necessary element for operation, but they are very helpful in defining the scope of RD&T responsibilities. In most agencies, the RD&T policy formally acknowledges the place of research activities in the business of the agency.

The policies may be a paragraph in length, but more likely are several pages, and detail the appropriate organizational structures, appointments or duties of affected individuals, operating procedures, approvals, and definitions of terms and priorities. The policies should name the organization within the agency for whom the policy applies.

The ultimate motivation for appropriate and relevant mission statements, goals, and policies is to define all aspects of the research unit so that it is a contributing member of the agency team.

2.3 Strategic Management and Planning

2.3.1 Definition and Purpose

"Strategic management is the process of articulating a future vision of accomplishment for an organization and planning, directing, and controlling the organization's entire range of activities to work toward the desired state or position... Strategic management focuses on an overall vision of where the organization should be heading, i.e., what it plans to accomplish and how to get it accomplished. It provides for the involvement of the entire organization in managing its people, processes, and products toward successful accomplishment of its goals and objectives." [NCHRP Report 331, "Strategic Planning and Management Guidelines for Transportation Agencies," NRC, December 1990.]

The most important reason for a strategic approach to the research unit's activities is to better meet RD&T customers' needs. The research unit persistently studies internal and external customers and their businesses. Research management strives to know customers so well that the customers' problems can be anticipated. A priority of the research unit is to have solutions to the customers' problems at the time the problems require a solution. Strategic management and particularly strategic planning allow research to position itself correctly—to be doing the right thing at the right time, and not just doing things right. Therefore, planning the research program is critical to RD&T efforts.

COMMENTARY:
Many agencies have excellent strategic management processes in effect. Research units required to be part of an agency's strategic management activities, for the most part, will base their operations on the agency's strategic methods. These research units are no longer simply asking what shall we do in the next fiscal year or in the next 3 or more years. They are asking questions such as: what is likely to happen in the future, what should we do in light of it, and how might we influence its outcome? In addition these organizations are not only planning what to do, but aligning the day-to-day operations and budgeting process with the strategic planning and management of their RD&T functions.
Strategic approaches to the work performed by the research unit add value to the products of research. A few of these benefits are that the topics being researched are in direct response to needs of the agency, the staffing/expertise of the research unit is appropriate for the research required, and implementation of research results is more focused and has more potential for expedited application.

2.3.2 Process

The seven essential components of the strategic management process for the research unit are as follows:

1. Development of the Mission Statement—Specification of the organization's basic function and responsibility, why it exists, what it is striving to achieve, and who its customers are;

Goals—Statements of ends the organization wants to achieve, but are not necessarily achievable in the near term; and
Objectives—Specific things the organization plans to accomplish for each goal with measurable, quantifiable results.

2. Environmental Scan—Identification of the strengths and weaknesses of the organization's internal environment and the opportunities and threats presented by the external environment in which the organization operates.
3. Strategy Development—Statements of how the unit will work toward achieving its goals and objectives in terms of its processes, products, personnel, resources, and organizational structure.
4. Action Plan Development—A set of specific, accomplishable, detailed steps implementing a particular strategy; including schedule of work elements, completion dates, and delineation of responsibilities for each step of the plan.
5. Resource Allocation—All resources - personnel, financial, and facilities and equipment - must be allocated in accordance with the organization's goals and objectives, strategies, and action plans.
6. Performance Measurement—Tracking implementation of the action plan, concurrent tracking of progress toward stated goals and objectives, and indication of changes needed.
7. Incentives Provision—Provision of a system of recognition and rewards.

COMMENTARY:

Although it is more desirable to work within an agency-wide strategic management process, a research unit may implement a strategic management process within its own organization. Moreover, strategic planning should be standard procedure within the RD&T arena.

The basic components of the strategic management process are interactive and ongoing, i.e., an organization is never completely finished with any step, only one iteration of it. The components feed each other. They also require continuous monitoring and modification so that each organizational unit is working toward the same desired end within a constantly changing external and internal environment.

The products of the strategic management process are comprehensive and fully involve all of activities of the research unit. The CAO or other senior manager to whom the research unit reports, and managers and others within the research group, as well as a strategic management "champion," must be active participants for the process to be successful.

The effort is considerable but the results are highly advantageous for the research unit. The process enables the research unit to maximize its resources to meet its customers' needs, to perform its

responsibilities most effectively, and to reward its personnel appropriately for successful accomplishments.

2.3.3 Product

As a result of its continuing strategic management activities, the following elements are in place in the research unit:

- Well-articulated, current mission statements, goals, and objectives;
- Organizational strategies for accomplishing the goals and objectives;
- Properly defined business activities;
- Business strategies;
- Business action plans;
- Strategically determined program budgets;
- Performance measures;
- Strengths, weaknesses, opportunities, threat analyses; and
- Rewards tied to performance.

2.4 Developing Customer Support

2.4.1 Purpose

To remain a vital unit of the Agency, the research function must respond to customer needs and solicit customer support internal and external to the Agency. In Section 1.0, Purpose and Context of Manual, it was stated that the research unit exists for the benefit of the Agency, its employees and other transportation agency users. Attaining this goal requires the support of our customers. Their support can best be achieved by involving them in the process of developing the program and generating the products. This ensures that their needs are considered and satisfied at all times.

COMMENTARY:
This section of the guide, involving outreach activities, has a significant impact on the research unit. The nature of the outreach activities is distinctively different from the technical activities in which the research staff developed its competency. Therefore, it is important to enlist the assistance of other agency units to effect the best possible climates and exchanges of information with contacts outside the research unit.

2.4.2 Process

2.4.2.A Research Partners

Research partners come from the ranks of the Agency, universities, companies affiliated with transportation (trucking firms, suppliers, contractors, etc.), transit authorities, consultants, local governments, regional agencies, FHWA, and the public. The partners involved and their level of involvement is different throughout the process. For example, Section 3.3, Research Committees, shows the interaction of the different groups in the committee structure. Section 4.1, Research Problem Solicitation, describes the interaction of the Agency with transportation institutions in soliciting research needs.

COMMENTARY:
The suggested list of potential partners in the research process is intentionally long. A state may decide that some of those on the list are not appropriate. A state may further decide that only some of the outreach partners listed should be involved, and then on an infrequent basis.

2.4.2.B Forums for Including Research Partners

B.1 Public/Private Meetings

Public and private meetings with the various research partners, industries, university transportation centers, suppliers, contractors, transit authorities, and local governments allow the different institutions to give their input on specific issues, while coming to understand their effect on other institutions.

B.2 Committees

All potential partners may be represented on specific committees, as defined in Section 3.3, Research Committees. The committee is the most procedural of the interactive techniques and enables non-Agency institutions to affect policy as voting members.

B.3 Institutional Discussions

Public-private meetings of individual institutions are held. For example, specific material suppliers, university transportation centers, or contractors can be assembled to discuss their research agendas or foster an implementation effort of studies affecting their institutions.

B.4 Seminars

Agency seminars enable researchers, users, and other experts in a specific field to become familiar with broader issues. Seminars, presentations, and discussions increase understanding of issues and promote research efforts for the Agency.

B.5 Requests For Research

All potential partners will be asked about research needs. Section 4.1, Research Problem Solicitation, defines this process.

COMMENTARY:
The intent of this section is to provide as wide a range of interactive techniques as possible. Although several options are suggested on the interactive effort of the Agency with the various research partners, the state research manager should decide which are appropriate for the organization. A state is in the best position

to determine how these partners can be most effectively served and involved in the process. It is possible that the best way to serve the customer may be by asking the customer for suggestions on research needs.

2.4.2.C Procedures

C.1 Forum Agendas

The nature of each of the forums described under Section 2.4.2.B. is unique, and a general agenda is outlined for them. Well-focused agenda items will be developed for each of the forums as follows:

- Public-private meetings highlight distinctive issues. An Agency representative should make a presentation at the meeting. A directed discussion solicits input from each of the institutions present. This type of meeting may elicit input to the strategic plan or research agenda.
- Committees, their agendas and the procedures followed are defined in Section 3.3, Research Committees. The committees assist in the development of the strategic plan, prioritize projects, monitor the progress of projects, or discuss the formation of the research work program with Agency management.
- Institutional discussions are conducted in a manner similar to the public-private meetings. The participants may be more familiar with the Agency's functions, permitting a less formal agenda.
- Seminars are the most formal of the meetings. Presentations are made by experts in the field, followed by an open discussion.
- Requests for research follow the procedures outlined in Section 4.1, Research Problem Solicitation. Meetings are held on an as-needed basis, determined by the research manager.

COMMENTARY:
Although broad outlines are suggested below for each of the forums for including research partners, specific agendas should be developed for all of them. Many participants may be new to the agency and its processes. Substantial guidance may be necessary for these participants at the outset of the meetings. In any event, the most important consideration is the satisfaction of the participants. This can be achieved through sensitive consideration of their concerns.
An agency may find that some of the suggested agendas may work better in other forums; in fact there may be effective agendas that are not mentioned.

C.2 Ensuring Feedback

In an effort to retain the interest of the research partners, all participants in the interaction process are given feedback on the results of the forums by means of a memorandum.

The program development process results in a research work program that is sent to all participants and agencies that were contacted for requests for research.

2.4.2.D Scheduling

Input for the development of the research work program is obtained from public-private meetings, institutional discussions and requests for research. To allow time in the development process, these forums are held at least 6 months before the date of submission of the work program to the FHWA.

The scheduling of the committee meetings is defined in Section 3.3, Research Committees. Seminars will be conducted as needed. All meetings are scheduled with the approval of the Research Management Committee.

> *COMMENTARY:*
> *The text implies the annual scheduling of program development meetings. This may not be practical or desirable in some states. Obviously, the text should reflect the states' desired frequency.*
> *The notation , that time should be allowed for submission of the work program to the FHWA, reflects that the entire program is shown to FHWA as a courtesy. Many state programs are not entirely funded by FHWA.*

2.4.3 Product

The success of a research program hinges on our ability to develop strong and lasting interactive relationships with all the beneficiaries of research. The outreach partners, forums and suggested forum procedures assist the research unit in strengthening program development, consensus building, implementation assistance, technical input and the bolstering of partnerships.

SECTION 3.0 RESEARCH, DEVELOPMENT AND TECHNOLOGY ORGANIZATION

3.1 Research, Development, and Technology Placement Within the Agency Organization

Formal and informal placement of the research unit within the Agency are each important to accomplishing its RD&T mission and goals. The formal structure is the location of the research unit on the agency organizational chart. The informal structure is the perceived fit of research into the agency based on the function it serves and its impact on the agency mission.

Research should maintain an effective place within the informal structure of the Agency. The process of innovation usually does not flow through the reporting hierarchy defined by the organization chart. Topics requiring attention that may soon develop into bona fide research needs, users willing to implement a new technology, funds available for technical research and other opportunities are often learned through a presence in the informal structure and communications within the agency.

COMMENTARY:

The state should indicate the position of research within the agency organizational (particularly the level of management to whom it reports) and its functional scope at the end of the first paragraph above. A copy of the agency organization chart should be placed in the appendix or in this section of the manual. A number of formal placements/structural arrangements are common among the state departments of transportation. The formal location of the research unit most often follows one of the following models:

- *Research unit reports directly to the chief administrative officer;*
- *Research unit reports directly to the chief engineer;*
- *Research unit reports to the highway construction and materials division management and may be physically located in/with the materials and test laboratory;*
- *Research unit reports to chief planning staff member, being co-located with others funded by FHWA SPR money; and less commonly*
- *Research unit is co-located with others performing strategic management services for the agency.*

Due to the traditional hierarchial structure found within transportation agencies, very often the higher placement on the organization chart reflects the broader scope of the research unit's program. In many agencies the number of layers of management may define the research function—fewer levels of management may indicate an agency-wide purview while many levels of management

may indicate a narrower field of focus. The research unit should be placed as highly as possible within the organization, corresponding to the mission and scope of the RD&T activities.
Transportation agencies traditionally have had many layers of management. However, during the past approximately 5 years, many agencies reduced (or are still reducing) the numbers of middle managers and other personnel thus producing a flatter organizational structure. During this time of change, the research unit should review its scope and seek proper placement within the agency based on recent structural and/or mission changes.
The research unit should have up-to-date, well-documented organization charts and diagrams of the procedures used in the RD&T program.
Furthermore, one of the most important items for a research unit, regardless of the location it occupies within the agency, is an enabling management. Such a management approach encourages maximum use of the expertise contained in the research unit by facilitating cross-unit functions and freeing communications among modal units and by encouraging risk taking and innovative approaches to implementation or other difficult-to-accomplish tasks that are beyond the research unit's direct authority. The influence and endorsement of top management in the RD&T activities is a particularly effective lever for operating within the informal structure of the agency.

3.2 Research Unit Organization

A chart of the organizational structure of the research unit is included in the appendix. The chart shows formal line responsibilities, project teams and matrix relationships with those inside and outside the research unit. Organization charts are useful for showing full-time equivalent staff members of the research unit and the technical expertise contained within the unit.

COMMENTARY:
Although the text refers to an organization chart in the appendix, the manual will have the chart—this guide does not include a chart.
There are several organizational models that state transportation research units tend to follow. Many of the structural and organizational arrangements are based on the type of RD&T effort performed by the research unit. Primary differentiation is often based on the amount of technical research, administration, and laboratory testing and evaluation services performed. However,

most likely the research unit will be organized in one of the three standard models or some combination of the three.
The three standard models are Line/function organization, Project organization, and Matrix organization.

- *In a Line/function organization, the function or technical expertise is emphasized. Each project may be assigned to a function manager for coordination. The specific function is performed and the project passes along to another functional or technical expertise area outside the functional organization within the unit. This type of organization allows flexible use of people—they can be switched from project to project as their technical expertise is required, and there can be high technical function quality. However, the model is not client or end-product (or process) results oriented, and there is a tendency for lack of coordination and accountability for the result and its timeliness. Examples would be structural engineers, statisticians, or finance and administrative personnel as separate and distinct functions within the organization.*
- *The Project organization model is composed of self-contained units (e.g., special projects for developing major systems or the Local Technical Assistance Program) having most, if not all, that is needed to develop the end-product or process. Each project would have its own technical experts, whatever the expertise may be, and others such as data processing and administrative personnel. Often this type of organization is used for large projects that can operate as a self-contained group within the research unit. Some of the agency reorganizations to goals/objectives-oriented teams that are currently popular are based on a project organization model.*
- *A Matrix organization couples features from both Line/function and Project organizations and contains equal lines of control and influence from each of them. Project personnel are drawn temporarily from the Line/function organization and remain with the project for its duration. Reporting authorities change with the project although "home base" remains the Line/function organization. Depending on the way a team is organized, many are matrix managed; staff retain a functional home base but work on various project teams.*

3.2.1 Available Resources

3.2.1.A Internally Available Resources

To conduct its mission, the research unit continues to retain internal resources, specifically, personnel, equipment, facilities, and funding.

A.1 Personnel

Research aspires to retain and recruit staff expertise in technical areas identified by the unit's goals and mission. Support staff should be adequate to maximize time and effort spent by the professional/technical staff.

A.2 Equipment

The physical research needs of the unit require equipment to conduct experiments, testing, and evaluations. While joint use of highly specialized equipment may be necessitated by the funds available, research projects have the assurance of access to necessary apparatus, machinery, and supplies. High-quality equipment helps ensure the accuracy of the research being performed.

A.3 Facilities

The physical research needs may require specialized facilities as well as unique equipment. Adequate laboratory and/or testing facilities to conduct research safely and effectively will be available to staff. A library, including off-site database electronic access, is also available to researchers.

A.4 Funding

The research unit receives funding from a variety of sources to fund RD&T activities controlled by its own unit and other units within the Agency. Federal-aid and state moneys are the primary funding sources; less common are other public or private grants and in-kind services supplied for specific projects. A number of the most commonly used sources are as follows:

- SPR funds—consists of 80-percent federal-aid funds which are matched with 20 percent by the states. The research unit's funds are 25 percent of the SPR funds for the Agency. The amount is legislated in the ISTEA of 1991.
- State funds—from general or transportation accounts of the State budget.
- 402 Safety funds—federal-aid funds from section 402 of the transportation legislation, for safety projects.
- Intelligent Transportation Systems, FHWA matching, or Federal Highway 100-percent funds—direct grants from the FHWA for specific projects.
- Other ISTEA-legislated funds—special project funds for research or of which research may be a part.
- Local Technical Assistance Program funds—50-percent federal match funds for each LTAP Center.
- Other Federal funds—grants from other federal agencies such as FTA, FAA, and others.
- National Science Foundation—grants for basic types of research efforts.
- Private Sector funds—cost sharing and consortia participation.

COMMENTARY:
The most significant funding issue is the availability of funds to accomplish the goals and mission of the research unit. Often, research units cooperatively fund activities with other agency units

or encourage the unit requesting research or technical assistance to fund the effort. Similarly, research units fund RD&T activities performed by other agency units. The budgeting process is particularly important, so that the appropriate amount of funds are reserved for the RD&T activities required by the agency.

3.2.1.B Externally Available Resources

There are many external resources available to the research unit. Some of them are within the Agency and outside of the research unit; however, many are external to the Agency. Such external resources are used as information sources, testing or equipment suppliers, contract research agents, and so forth. A high degree of contact is maintained with outside resources for research coordination, prevention of duplication of research effort, enhancement of technical expertise and an increase in knowledge. A solidly built network of external resources is necessary to support cost-effective and technically superior research efforts.

External resources provide the research unit with staff/expertise, equipment, and facilities not available within the Agency, thus greatly expanding the research capabilities of the Agency. For use of very costly equipment and infrequent use of specialized equipment or facilities, cooperative arrangements with others in the research community are continuously sought.

The network of external resources includes the following:

- Other state transportation agency research directors and technical experts in other transportation agencies;
- FHWA, division, regional, and headquarters staff, as well as those at Turner-Fairbank Highway Research Center;
- Transportation Research Board (TRB);
- American Association for State Highway and Transportation Officials (AASHTO);
- Standards setting organizations: National Institute for Standards and Technology (NIST) and the American Society of Testing and Materials (ASTM) among others;
- Research laboratories and institutes, private and federal;
- Academic institutions;
- Consulting community; and
- Professional and trade associations.

COMMENTARY:
The most important aspect of using resources outside the agency is knowing what resources are available and how to access them. Establishing communications and professional contacts prior to a need arising greatly enhances the potential for use of the external resource.

3.2.2 Categories of Research

The categories of research performed by the unit fall into two areas: basic research and applied research. Basic research involves the study of phenomena whose specific application has

not been identified; the primary purpose of this kind of research is to increase knowledge. Applied research involves the study of phenomena relating to a specific, known need in connection with the functional characteristics of a system; the primary purpose of this kind of research is to answer a question or solve a problem.

In general, the research unit programs are highly applications oriented. Although the public sector environment makes it very difficult to perform anything other than applied research (e.g., generate a specific product that can be used to improve transportation), efforts are made to reserve research funds to perform basic research efforts.

> *COMMENTARY:*
> *For most research units, the category of research is not an issue. The purpose of the research program is to allow the research unit to perform applied research on specific problems encountered by the agency. The effort to perform basic research is usually reserved for university or industry contracts.*

3.2.3 Types of RD&T Activities

The RD&T program is composed of various activities as follows:

- Research Study: This is a systematic inquiry into a subject in order to discover or revise facts and usually includes analytical and experimental efforts to increase the understanding of causative relationships necessary for meeting the specific needs of the agency. In general the studies are longer-term efforts and are different from technical assistance/consulting described below. These efforts can be performed by staff or a consultant.
- Synthesis or State-of-Practice Study: This is a study that examines all literature published on a specific topic and summarizes the results reported; such a study generally reports on the state of practice of the topic and gives recommendations regarding the best or most effective practices found by various organizations using the methods or products under study.
- Continuation Study: This is used to designate, in the budget, the money required to continue research studies beyond the present fiscal year. It is an easy way of distinguishing new project budget requests from projects in progress that require continued funding.
- Technical Assistance/Internal Consulting: This includes brief analyses, experiments, or literature searches for operating or administrative units to develop answers to specific and immediate questions. Such assistance is provided where special expertise or equipment is available in research. The effort usually results in a brief technical opinion or a short experimental project. The results are prepared for the requesting unit and generally are not formally published or distributed widely.
- Development Project: This is an adaption, modification, and testing of an idea, process, or product for practical use under field conditions. Development is a

continuation of the research process and conducted to verify expected performance and improve the utility of the item.

- Technology Transfer: This consists of post-research activities to inform and to encourage practical use of innovations; in its broadest sense, technology transfer can encompass any activity that causes an innovation to occur. The research unit is generally responsible for dissemination of research results within and outside the organization and encourages training, conferences, symposia, and other events to facilitate the flow of information regarding new and successful technologies that may improve the transportation services delivered by the agency or by others. Technology transfer activities may include informing other agencies about research and technology originating in the agency or acquiring technology information from others to be used by the agency.

COMMENTARY:
In general, state transportation agency research programs contain most of the types of activities described in this section. Some types of activities are emphasized more than others depending on the specific orientation of the agency. The profile of a research program should match the expectations expressed in the mission and goals of the research unit and of the agency. The activities emphasized should be those best suited to fulfilling the articulated missions and goals.

3.3 Research Committees

3.3.1 Purpose

The purpose of research is to bring about improvement by studying ways to enhance the process, method or materials in use. Of the many activities delineated to develop and maintain customer support under Section 2.4.2.B, Forums for Including Research Partners, the committee is perhaps the most important.

Through committees, research staff formally maintain contact with the staff of the Agency and outside institutions. Committees are useful in developing and updating a strategic plan, providing input for the periodic solicitation of problems, setting priorities for projects selected for the work program, giving advice and general guidance during the process of the project, and serving as important conduits for the transfer of research results.

COMMENTARY:
The importance of the committee cannot be overstated. An effort should be made by the agency to involve committees with all aspects of the research; an open and interactive research process is apt to get its products into the marketplace. The institutional interaction that the committees foster can give a definite boost to the importance and implementability of the research results.

Although the committees listed below cover all aspects of the research process, they do not preclude the existence of others. For example, large states may desire regional committees, a problem solicitation committee or an implementation committee.

As important as the committee is, there is no one to organize the meeting other than the research unit. Considerable time and some set-up cost will be involved.

There may also be a desire to limit the number of committees or have none. This section expands on one of the suggested forums for including research partners outlined in Section 2.4.2.B. In that section, several interactive methods were listed that a research program could draw from to strengthen the program and conform to FHWA regulations. The result of not including some committees is also discussed.

3.3.2 Process

3.3.2.A Strategic Plan Committee

A.1 Function

The Committee develops the 3- to 5-year plan for research activities. The plan addresses major categories and subcategories.

A.2 Membership

Committee membership is drawn from the following:

- The management of the Agency,
- The research unit,
- The operating units of the Agency,
- Public transit agencies of the State,
- The FHWA Divisional or Regional office,
- Organizations within the State, affected by transportation (truckers, contractors, etc.),
- Academia,
- Private consultants, and
- Intermodal groups.

A.3 Meeting Agenda

The meeting agenda covers the following items:

- The mission and goals of the Agency,
- The transportation and economic environment of the State and region,
- The problems facing the State's transportation system,
- The major categories of concern for the Agency, and
- The detailed emphasis areas for research.

The research unit provides all material and makes all arrangements for the meeting. The meeting minutes and summary of results are compiled and distributed by the research unit. A meeting facilitator will participate.

COMMENTARY:

The agenda of this committee is vitally important, because the committee's efforts will determine the research emphasis areas for the near term. Although a facilitator will advance the meeting agenda, brief presentations (by recognized experts) should be considered to cover the mission and goals of the agency, the transportation and economic environment, and the transportation problems facing the state. Discussion of each of these items should enhance the development of the research emphasis areas.

A.4 Meeting Frequency and Location

The Strategic Plan Committee meets biennially at the headquarters office of the Agency.

COMMENTARY:

More frequent meetings of the Strategic Plan Committee are not necessary, because the plan has a 3- to 5-year expectation. It may also be difficult to bring the committee together more frequently than biennially.

The Strategic Plan Committee can give the research unit and the Agency the proper start to achieve a relevant and implementable program by producing a firm foundation. The first step in an interactive process may be a strategic plan developed with the assistance of the statewide transportation community. The membership and agenda are subject to modification, based on the needs and desires of the Agency.

An agency may choose not to form a Strategic Plan Committee. Agencies can determine research needs by using the interactive techniques mentioned in Section 2.4.2.B., Forums for Including Research Partners.

3.3.2.B Research Advisory Committee

B.1 Function

The Research Advisory Committee reviews and prioritizes the problem statements and recommends projects to the Research Management Committee for the next work program (Section 4.2.2.B, Project Prioritization). The Research Advisory Committee also bolsters the implementation effort of the Project Committee (Section 3.3.2.C, Project Committee, and Section 9.0, Implementation Process).

B.2 Membership

Committee membership is drawn from high-level technical and managerial staff in the following:

- The research unit,
- The operating units of the Agency,
- Public transit agencies of the State, and
- The FHWA Divisional or Regional office.

COMMENTARY:

Members of upper management are not included in this listing because they will have review and approval authority on the Research Management Committee. (Section 3.3.2.D). If a Research Management Committee is not formed, upper management should be used to complement the Advisory Committee.

Those organizations within the state that are affected by transportation activities (such as trucking firms, contractors, academia, and private consultants) are not included because of the potential for future conflict on consultant or capital project contracts.

B.3 Meeting Agenda

The work program issues included by the Committee at its meeting are as follows:

- The function of the Agency,
- A review of the emphasis areas of the strategic plan,
- The technical merits of each problem,
- The cost estimates of each problem, and
- The ranking of the problems by the following categories:
  - Staff research (project and technology transfer activities),
  - Contract research,
  - Pooled fund research,
  - University Transportation Center research,
  - NCHRP or TCRP problem submissions, or
  - Other shared funding possibilities.

Issues related to implementation activities that should be covered at the committee meeting include the following:

- A review and discussion of the objectives of those projects nearing completion,
- A critique of the project's findings,
- The development/review of the implementation plans for each project,
- The assignment of responsibilities for the components of the implementation plans,
- An assessment of implementation impediments and guidance in overcoming them, and
- Recommendations on specification and design improvements.

The research manager chairs the committee and prepares the agenda and meeting material. The meeting minutes and summary of results are compiled and distributed by the research unit.

COMMENTARY:

More details on the work program elements of the meeting are given in Section 4.2.2.B, Project Prioritization. More details of the

interaction of industry in the implementation process are given in Section 9.0, Implementation Process.

B.4 Meeting Frequency and Location

The committee meets once a year in June at the central headquarters.

COMMENTARY:

Consideration should be given to calling more frequent meetings of this committee, particularly if the ongoing projects warrant implementation review.

The selection of June for the meeting allows time for a subsequent meeting with the Research Management Committee and the submission of the work program to FHWA by early September. Obviously, this schedule should be altered to coincide with the time of the submission of the work program in the state.

A Research Advisory Committee may be the closest interactive ally that could be formed to guide the research unit. All of the development aspects and some of the managerial aspects of conducting research are discussed with this committee.

If this is the only committee formed, this could be the most helpful. Without it, the research unit would take on the program development and implementation oversight roles unassisted.

The membership and agenda should be selected according to the Agency's needs and desires. Some state research programs may be too large for one committee to perform effectively. Several committees, covering functional areas (such as structures, pavements, safety, planning, traffic, etc.) may be desirable.

3.3.2.C Project Committee

C.1 Function

The Project Committee (1) works with the principal investigator, research staff and/or the contractor to develop the project work plan, (2) assesses the technical status of the project by reviewing reports and holding discussions with project staff at meetings, (3) evaluates overall progress, and (4) advises project staff on an individual project basis. The committee also seeks to advance the technical aspects of the project.

C.2 Membership

Committee membership is drawn from the following:

- Research unit and project staff,
- Operating units of the Agency most affected by the results, and
- Nonagency organizations with expertise in the area of research.

COMMENTARY:

The importance and/or sensitivity of the project may warrant a project committee being drawn from a much larger arena. For

instance, regional associations and other government agencies or entities could be represented on the committee of a project having broad policy implications. Contractors and suppliers could be represented on the committee of a project researching the use of a new material or change in construction procedures and specifications.

The state must decide who will serve as chairperson for this committee. Although the role of chairperson is given to a research unit staff member in the text, this role could also be filled by staff from an operating unit.

C.3 Meeting Agenda

The meetings are convened by the chairperson and each meeting of the committee covers the following:

- A review of project objectives,
- A discussion of the milestones and general progress of the project,
- A discussion of project problems and their solution, and
- A review of the implementation process and any impediments to it.

The research manager appoints a staff member of the research unit as the chairperson of the committee. The research unit makes arrangements for the meeting and is responsible for taking the minutes and distributing them to the membership.

COMMENTARY:

The agenda for the Project Committee should be organized to take full advantage of the expertise of those attending. Attendees should be encouraged to speak freely and openly, allowing a free-wheeling atmosphere for the discussion of each agenda item. In this setting, those most affected by the research will be more likely to voice their concerns. A meeting that is too formal may prevent thoughts from being expressed.

C.4 Meeting Frequency and Location

All meetings are called by the chairperson. At the beginning of the project, a meeting is called to ensure that everyone understands the project goals, objectives, and methodology. Subsequent meetings are called at project milestones, potential project redirection, or other decision points. The meeting location should accommodate the membership. Contact with the principal investigator is maintained by the chairperson. Project staff will present the technical status.

COMMENTARY:

Each project has its own project committee or task force. While daily operations are the responsibility of the project manager (principal investigator) and research management, the Project

Committee is an important source of information for the Agency and the marketplace.

In the absence of a Project Committee, the role of project champion should be the research principal responsible for the project conduct, or the role could be shared with the Research Advisory Committee. Another alternative would be to integrate the projects with some of the Forums for Including Research Partners mentioned in Section 2.4.2.B.

If the committee is used, its purview may not include all the functions listed. Functions should be added or deleted as appropriate.

3.3.2.D Research Management Committee

D.1 Function

The Research Management Committee approves the research work program and all major program and project activities.

D.2 Membership

Committee membership is drawn from the following:

- Upper management of the Agency,
- Research management,
- FHWA, and
- State institutions and organizations (on a rotating basis).

COMMENTARY:

The voting membership of this committee can be restricted to the upper management of the agency. The committee, however, provides another opportunity for the agency to open its research process to non-agency organizations. The close relationship that research has developed with universities, for example, makes academic membership on the committee natural. In addition, the expanding importance of environmental considerations invites the participation of the appropriate state agency on the committee. Each state has a unique situation, hence it would be up to the state to decide on the committee membership under D.2 above.

D.3 Meeting Agenda

The work program development portion of the agenda includes the following:

- Details of the program development process (including the participating staff and agencies),
- A review of the emphasis areas of the strategic plan,
- A review of the research unit's budget,
- A discussion of the recommendations of the Research Advisory Committee,
- The approval of the new projects in the categorized list (explained in B.3 above, Research Advisory Committee), and

- The approval of all other items in the work program (this includes the carryover projects and other financial obligations the research unit may have).

Research unit operations are included in the agenda with items as follows:

- Staff needs (e.g., training, office, and disciplines),
- Equipment needs (e.g., field and office),
- Contractual agreements (e.g., procedures and status), and
- Implementation efforts.

Other matters that may be included in the agenda are as follows:

- Conferences (e.g., sponsored or attended),
- Contacts (e.g., individual or organizational), and
- Presentations on significant projects.

The committee is chaired by the Assistant Commissioner to whom the research unit reports. Meeting arrangements, minutes, and their distribution are the responsibility of the research unit.

COMMENTARY:

This meeting is vital to the research staff and imposes the burden of preparation on the unit. As noted in Section 4.2.2.B, Project Prioritization, severe time constraints might limit discussions vital to the research unit. Accordingly, the research unit should prepare material beforehand that would expedite the progress of the meeting. For instance, in the program development portion of the meeting, the new projects should be ranked in the categories listed in Section 3.3.2.B, Research Advisory Committee. Recommendations should accompany this list, particularly if funding is a limiting factor.

In the operational review portion of the meeting, research staff should prepare summary listings of the items that will be covered.

D.4 Meeting Frequency and Location

The Research Management Committee meets in July, at central headquarters.

COMMENTARY:

The selection of the timing of the meeting should be determined by the submission of the work program to FHWA and the state budget cycle. Sufficient time should be allowed to modify and print the program subsequent to the meeting and prior to submission. If management is agreeable, several meetings can be scheduled throughout the year.

This is the most influential committee involved in the research process. It has the authority to make the research process smoother and bolster the resources of research to overcome problems and accelerate projects. The actual operation of the committee is covered in Section 4.2.2.B, Project Prioritization.

As noted above, if this committee is not formed, responsibility for management could be assigned to the Research Advisory Committee. If the Management Committee is formed, the membership and agenda could be selectively chosen from the suggestions below.

3.3.3 Product

The section on Research Committees sets up an important organizational framework. This framework offers the research unit continual interaction with its customers. The results of this interaction include a list of research problems, prioritization of the problems, building and strengthening of potential partnerships, development of a work program, technical assistance on projects, implementation assistance, and an important source of information for upper management of the Agency. Proper functioning of the committee structure enhances the completion and utility of the research and intensifies the importance of research and the research unit.

SECTION 4.0 PROGRAM DEVELOPMENT

4.1 Research Problem Solicitation

4.1.1 Purpose

The primary focus of the research unit's strategic plan is to identify research emphasis areas. These research emphasis areas are used in developing the work program. The problem solicitation process is the first step in putting the emphasis areas expressed in the strategic plan into the project formation process.

The solicitation process provides field and operating staff with an in-house resource to which they can submit problems in order to receive an objective review, Agency contractors with a formal process which allows them to air their concerns, and the academic community with a way to submit problem statements and unsolicited proposals.

> *COMMENTARY:*
> *Not all agencies have a strategic plan. The above text should be modified accordingly. In place of "the strategic plan," in the text, substitute either "the solicitation process" or "the Agency's critical needs." Follow through in the first paragraph with the appropriate changes.*
> *The state's research unit organization and its formal involvement with the academic community may result in several modifications to the process described below. As it is written, the basis for the procedure assumes that a state research unit controls the development of the program, while acting in consort with management. If the control is shared with another institution or if the problems are developed by a committee, text should be added to both 4.1.2.A., Potential Problem Submitters, and 4.1.2.B., Methodology, to reflect the unique arrangement that exists.*

4.1.2 Process

4.1.2.A Potential Problem Submitters

A.1 Within the Agency

The primary customers for research are the operational units of the department, which have the responsibility to plan, design, construct, operate, and maintain the transportation networks in the State. Annual solicitation requests are forwarded to the bureaus and divisions of the Agency, encouraging all staff to submit problem statements. This is an important activity of the research unit in supporting its customers, who manage the transportation systems.

A.2 Organizations External to the Agency

An efficient transportation system cannot exist without direct support from related organizations such as the FHWA, universities with civil engineering and graduate transportation programs, private transportation associations, regional organizations, public transit agencies,

trucking associations, and associations representing contractors and suppliers. Some of these organizations have research capabilities; others have needs that require the technical or financial support that the Agency can give through its research unit. The research unit has the responsibility to nurture the suggestions of these organizations to ensure that all problems are reviewed for possible incorporation into the research work program.

A.3 Transportation System Users

The vehicle drivers and passengers and public transit users are the direct recipients of the efforts of transportation officials to provide the safest, most comfortable, economic, and efficient systems of transportation. The Agency's application and operation of the transportation system are the daily circumstances of the system users. The research unit has the responsibility to canvass the users' insights and comments for potential problems.

COMMENTARY:
The effects of the transportation system are far ranging and it is incumbent upon the agency to involve a broad spectrum of participants in the solicitation process. When the entire program development process is considered, it is obvious that the problem solicitation portion gives a very extensive review to the suggestions received. If this fact is made known to those asked to solicit problems, the enthusiasm for participation may increase. The solicited problem will not be considered a useless exercise by a potential submitter, but one of agencywide involvement.
The research manager and the agency should solicit potential problems from those participants in the state associated with transportation. All of the following suggested participants may be appropriate.

4.1.2.B Methodology

B.1 Techniques for Requesting Problem Statements.

All of the following techniques are acceptable to the research unit in requesting or receiving research problem statements.

COMMENTARY:
The use of a technique to elicit the transportation research problem needs is as important as the participants solicited. Each suggestion listed below has its advantages. The main point of this section is to encourage research managers to contact the participants for their ideas and use an interactive form of exchange of information.

B.1.1 Solicited

Annual requests for problem statements are sent to the participants listed in A.1 and A.2 above. The problem statements originating within the Agency are screened by the management of the functional areas of the Agency prior to submitting them to the

research unit. Communication with non-Agency organizations is maintained by the research unit to ensure that the submitted problem statements involve statewide transportation needs.

B.1.2 Unsolicited

Problem statements are accepted at any time. Consideration is given to any problem for inclusion in the research work program, even though it does not conform to a stated area of need. Statements are accepted from anyone listed in A.1 and A.2 above.

B.1.3 Brainstorming/Multi-Agency Meetings

Biennially, representatives of the operating units of the Agency, FHWA, universities, regional organizations, public transit agencies, contractor and supplier associations, and consultants are assembled to brainstorm about the transportation research needs of the state. The research unit coordinates the meeting, which is organized into five separate areas: operations management, infrastructure management, safety, environment, and public transit. A methodology will be devised prior to each meeting to determine those problems that will be selected in the process.

B.1.4 Literature Scanning

Research staff review publications and reports throughout the year to extract ideas pertinent to the operations of the department. The motivation and objective of the scanning is the satisfaction of the needs of the research department's customers. Innovation, not technology, is the impetus behind the reviews. All suggestions raised through this technique are discussed and developed with the appropriate functional units before submitting them as problems in the program development process.

B.1.5 Questionnaire

Biennially, the research unit distributes questionnaires, on a random basis, to elicit specific problems from the transportation system users described in A.3, above. The focus of the questionnaire is the travel experience of the public as it relates to the safety, congestion and convenience of trips.

B.2 Basis for Problem Statements

Focused problem statements are the result of well-defined needs. The research unit defines needs, responds to operational issues, and acknowledges the opinions of transportation professionals in forming a basis for accepting problem statements.

COMMENTARY:
Emphasis areas may be defined either with or without a strategic planning process. Section 3.3.2.A, Strategic Plan Committee, outlined the use of a committee to help with the plan development. If emphasis areas do not form the basis for the research program, two other options are available. Operational/Natural Disaster Issues could be a basis, and it is suggested that it be included in the manual. The third option, Unrestricted, offers the submitters the ability to cover a full range of issues.

B.2.1 Defined Emphasis Areas

The solicitation request lists the emphasis areas within each of the major categories defining the Agency's near-term needs. Research problem statements received in response to this solicitation request are expected to conform to the stated emphasis areas. Critical issues are an exception and are explained below.

B.2.2 Operational/Natural Disaster Issues

Agency management decides on the critical issues to be considered for research, which can take any of the following forms:

- Policy or legislative concerns that require the attention of the Agency;
- Regulations developed by other agencies in government that may affect the department, demanding research;
- Recurring natural disasters that may require research; and
- Serious operational problems that may force the initiation of research.

B.2.3 Unrestricted

A solicitation for research problems is issued to the participants listed in A.1 and A.2 above without restriction to emphasis areas. The potential for transportation improvements through research can often be found through the brainstorming of individuals, unencumbered by the restrictions of emphasis areas.

B.3 Problem Format

Form 4-1 in the appendix, containing the information listed below, is sent to all prospective problem submitters. All submitted problems are expected to be on this form.

COMMENTARY:
If time is to be saved in the committees' reviews and discussions of the problem statements, an explanation of the various items on the form should be detailed. The submitter has to explicitly define the problem. The back of the form can be used to give examples of each item requested. A sample Form 4-1 for a Research Problem Statement is included in the Appendix of the Guide. If critical areas have not been designated, a substitution for the emphasis areas should be made.
Under the Submission Schedule, Section B.3.7, substitute the dates that conform to the research process in the individual state.

B.3.1 Problem Statement

When stating the problem, a submitter is expected to give an explanation of the existing problem and the situation that could exist if conditions were different. All the circumstances surrounding the problem should be explained. Often a problem is only known to a few people, so it is important that as much detail as possible be included in the problem statement.

B.3.2 Emphasis Area

Every few years, the Agency reviews its situation to determine those issues that may be critical to its operation in the near term. The list is published for the benefit of department staff. Research staff must pay special attention to the critical issues, primarily because the research unit is one of the uniquely supportive units of the department that

can address the critical needs and put considerable resources to work on them. The form used to submit problem statements lists the emphasis areas.

B.3.3 Background

Usually, the existing situation described in the problem statement has been the result of a long history of activity. The history leading to the current condition is important to an understanding of the problem. If there is literature available on research studies related to the problem, it could give essential documentation on experiments that may have been conducted. This information is valuable to further reviews of the problem and experimental designs in potential research projects.

B.3.4 Scope of Work

An important aspect of any problem statement is a clear list of the objectives of the requested research. Detailing an approach to attaining the objectives allows reviewers the opportunity to more accurately judge the potential success and cost of the research.

B.3.5 Implementation Statement

The primary purpose, and hence objective, of the research effort is to improve the operational responsiveness of the Agency. Because the implementation process is lengthy and involved, assurances of a high probability of actual operational improvements assists in advancing a problem statement. Many submitters may not have a firm grasp on an implementation process; research staff may be in a better position to complete this part of the statement.

B.3.6 Time and Cost Estimate

An estimate of the time and cost of the study is helpful in planning the various elements of the work program. At the problem submission stage, the time and cost estimates are based on the initial scope of work and are very uncertain. These estimates are expected to be adjusted at every stage of the review.

B.3.7 Submission Schedule

The research unit mails the solicitation request to all potential problem submitters early in January. The problem statements can be submitted at any time, but submitters are informed of the deadline for the upcoming fiscal year's program. To allow time for research reviews prior to the Research Advisory Committee meeting, submitters are asked to submit problem statements by March 1.

4.1.2.C Problem Screening by Research Staff

Upon receipt, research staff are assigned to review the problem statements based on the emphasis area of the submissions. It is the responsibility of the assigned staff to complete the reviews described below in time for the Research Advisory Committee meeting.

COMMENTARY:
Some states may treat the problems received as completed work plans. In these cases, some of the screening process below can be omitted. With all other solicitation processes, all of the options listed below should be appropriate.

C.1 Discussion With Submitters

Research staff may have at least two discussions with the problem submitter. The first probes for all conditions or circumstances under which the problem exists. This information is used in discussions with other affected units (C.2) and to conduct a literature review (C.3, below). A follow-up discussion may be held with the submitter, at which time the statement is refined and the time and cost estimates revised. It may be appropriate to defer any action on the problem either because of recently completed or ongoing work or because the affected operating units cannot change their current practice.

C.2 Discussion With Affected Units

The research staff discusses the effect of research on the problem with the management of the unit to determine if the proposed study might improve the operation of the unit. If the submission came from outside the organization, the affected unit is asked to assess its potential for implementation. Refinements to the submission or rejection of the problem can result from these discussions.

C.3 Literature Review

After discussing the problem with the submitter and the affected units, the research staff conducts a literature search. The details of the search, which provide insights to the problem area, are discussed in Section 8.3, Information Resources. This information helps avoid unnecessary duplication of ongoing or completed research and enhances the problem statement in subsequent discussions, particularly with the submitter and the Research Advisory Committee.

C.4 Time and Cost Revisions

With the discussions and literature search completed, refinements are made to the time and cost estimates for the work. These revisions are important in deciding the size of the research program.

COMMENTARY:

The research screening effort can be the most time-consuming part of the entire program development process. Administrative costs to the research program are hidden in this part of the process. However, the more exhaustive the screening process, the smoother the committees' review, recommendation, and decision processes that follow in Section 4.2.2.B, Project Prioritization.

Information Resources, Section 8.3, is important in the screening process. Without a literature search, committees must rely on the limited knowledge of staff. Besides the TRIS review, there is other literature that staff can pursue using the references found in the initial articles.

The screening process can be bolstered by the participation of the research management staff in discussions with non-agency submitters. This conveys that the agency is giving appropriate attention to the problems. This is another way of showing submitters that the agency desires and wants their involvement.

4.1.3 Product

The solicitation and research screening process provides the most complete and accurate information in the program development process. All necessary participants are involved in the solicitation process. Sufficient guidance is provided to the participants in defining the research problem statements, and a complete screening of the problems furnishes written literature and submitter reviews. With this effort completed, the other committees and management have assurance that ample information has been provided for their discussions and decision.

4.2 Project Selection Process

4.2.1 Purpose

The work program depends on a well-defined program development process. The project selection portion of the development process should be comprehensive in the functional scope of the reviewed projects and in the participatory nature of the involved staff. It must include department management and be designed for review by all participating parties.

Setting priorities for the problems received in the solicitation process allows the research unit to develop a work program within the limits of its resources. Although several shared funding arrangements (e.g., pooled fund projects) and partially supported institutions (e.g., NCHRP and UTC) make the determination of actual financial limits problematic, prioritizing ensures that the most important problems are discussed and advanced for consideration.

4.2.2 Process

The following factors are used by the Agency in determining the projects that are selected for the research work program. The Research Advisory Committee takes the factors into consideration in determining the work program that is recommended to the Research Management Committee.

> *COMMENTARY:*
> *Several factors may be considered in the project selection process. In addition to choosing from those suggested below under Agency/State Needs, Resource Limitations and Project Prioritization, a state should consider others that may be unique, such as department policy, organization, state/ university relationship, existing legislation, etc. Only one of the three methods of selecting projects may be primarily used by a state. For example, if Agency/State Needs is the method used, only some aspects of the other two may be included. It is important that the appropriate selection of techniques are taken from each of the main sections in putting together the selection process.*
> *The project selection process inherently involves a prioritization of projects, even if the project prioritization process, outlined in*

4.2.2.B, below, is not formally used. There are resource limitations which put upper boundaries on the number of projects that can be included in each of the funding sources. There may be compelling state needs which force a choice between the remaining competing projects.

The state should choose those selection factors that conform to the organizational and structural systems within the agency. This text should also reference the appropriate committee structure of the agency.

4.2.2.A Agency/State Needs

A.1 Critical Needs (Emphasis Areas)

The problem statements are subject to a comparative review with the current critical needs of the Agency. Section 2.3, Strategic Management and Planning, outlines the emphasis areas and Section 3.3.2.A., Strategic Plan Committee, details the development of the emphasis areas. The current critical needs are on file in the research unit and are of utmost importance for the Agency in the near term and take precedence over all other project selection factors.

A.2 Operational Efficiencies

Staff of the Agency strive to have the operational procedures of the Agency conform to the most efficient practices known to exist. The research unit continuously endeavors to advance those studies and investigations that promise the most cost-effective procedures and practices, expending extra effort in supporting the problem statements that address operational efficiencies.

A.3 Emergency Situations

In conjunction with the Research Advisory Committee, the research unit responds quickly to emergency situations. The required response may take the form of site or procedures inspection by expert research staff, contract negotiations with an expert consultant, or the development of an organized research project. Agency management decides the emergencies that preclude following the normal procedures for the inclusion into the research work program.

A.4 Legislative Support and Response

Research staff are available to respond to requests of the state legislative body. The requests may be associated with the development of state legislation or with the requirements of recently enacted state or federal legislation. Legislative development may require expert testimony, the investigation of specifications, the development of procedures to satisfy legislative mandates or the development of an organized research project that will either satisfy or institute long-term legislation. The response of the research unit will be as quick as possible. In some cases, the formally instituted project selection process may not be followed.

COMMENTARY:

The Agency/State Needs are written in broad terms and can be modified for specific agency conditions, especially the legislative support and response section. The actual project selection process may be quite variable. The suggestions made in the text can be easily interchanged with each other.

If a contingency cannot be made in the work program for the inclusion of emergencies and legislative support issues, there may have to be a rescheduling of other projects, if either of these situations arise.

4.2.2.B Project Prioritization

COMMENTARY:
The process described below goes beyond a strict adherence to project prioritization. Other aspects of the program development process (Section 4.0) are included to ensure continuity with the entire process. As an example, the role of the Research Management Committee can be expanded in this aspect of the program development process to allow for the contingency of management's reordering of the priorities set by the Research Advisory Committee. Although written in definitive terms, the different components of the prioritization process should be altered to conform to the unique goals and organization of the individual agency.

B.1 Criteria

In conjunction with the factors listed under Agency/State Needs and Resources, each problem received is evaluated using the following criteria:

- Does it address a critical need (emphasis area) of the Agency?
- Is there a high probability of success (consideration is given to a project where the potential benefits warrant a high-risk effort)?
- Is there ongoing or planned research on this specific problem, as determined by a TRIS search (Section 8.3)?
- Are the estimated budget and schedule acceptable, as verified in a review with the problem submitter (Section 4.1.2.C, Problem Screening By Research Staff)?
- Have the Agency units that may be affected by the research either proposed the problem or do they have positive comments on the suggested research?

COMMENTARY:
The criteria can be defined in more explicit terms and other items should be added to conform to the state's desires. For instance, if the agency or research unit has a strategic plan, reference to the strategic plan can be made instead of "a critical need of the agency."
The criteria listed can be applied by whatever group the agency uses to prioritize the problems received. The criteria do not specifically note the state's current or statewide needs, but this consideration is implicit in the first criterion listed, as an emphasis area of the strategic plan. As noted in prior sections, the reference

to the strategic plan should be replaced with "the Agency's critical needs," if that is appropriate. If the solicitation of problems was open to any issue, the first criterion should be omitted.
Because implementation is a primary aim of the research, the input of affected agencies is vitally important. This input should be discussed at the committee meeting by all participants. If there is no committee to set project priorities, however, the research staff should have considered them during their discussions in their screening process (Section 4.1.2.C).

B.2 Committees

The Research Advisory Committee (Section 3.3.2.B) uses the criteria of 4.2.2.B.1 to judge the technical merits of the problems and recommends a priority list of projects for management's approval. The Research Management Committee (Section 3.3.2.D) approves the content of the work program.

COMMENTARY:
Complete details of each of these committees can be found in Section 3.3.2. If the project prioritization function of the Research Advisory Committee is performed by another group, such as the research staff, the text should be changed accordingly. If neither committee is used, this subsection should be deleted and the text of B.1, Criteria, should be expanded to indicate which group performs the function (this may be the research unit).

B.3 Procedures

B.3.1 Problem Rating by Committee

The results of the screening process, conducted by the research staff (Section 4.1.2.C) and including commentary on discussions with submitters and affected units, a literature review of the topic, and estimates of the time and cost of a potential study, are given to the Research Advisory Committee before their meeting. This information helps the committee members review the submissions, which they will rate on the basis of the Agency/State needs and the criteria in Section 4.2.2.B.1.

B.3.2 Balloting

Committee members submit the rated problems to the research unit for distribution to the other members, before the meeting of the Research Advisory Committee. Research staff averages the rating of each problem for use by the committee as a starting point for discussion at the meeting. The committee uses all aspects of the Agency/State Needs (4.2.2.A), Criteria (4.2.2.B.1) and Resources (4.2.2.C) to determine both the category for conducting the research and recommending a high-, medium- and low-ranked list of projects in each category.

B.3.3 Meeting Agendas

The Research Advisory Committee discusses the function of the agency, the emphasis areas of the strategic plan, the technical merits of each problem, the cost

estimates of each problem, and the ranking of the projects and other matters as defined in Section 3.3.2.B. The Research Advisory Committee members discuss all problems submitted. The most extreme (high- or low-ranked) problems are addressed by their raters. Eventually, a consensus is reached. The priority listing of projects is then categorized into high, medium and low groups by categories as follows:

- Staff research (project and technology transfer activities),
- Contract research,
- Pooled fund proposals,
- University Transportation Center research,
- NCHRP proposals, and
- Other shared funding proposals.

The members of the Research Management Committee are informed of the details of the process (including the participating staff and agencies), review the emphasis areas of the strategic plan, review the budget, discuss the recommendations of the Research Advisory Committee, approve a final categorized list of projects, allocate funding, discuss the policy implications of the recommendations in arriving at a final work plan and consider other matters as defined in 3.3.2.D.

The agendas for both committee meetings are prepared by the research staff.

COMMENTARY:

The prioritization process can take several forms. If there is time, the committee members can refine the final list in a rank order, rather than the high, medium or low groupings. The categorization of the list by staff research, contract research, etc., (shown in 4.2.2.B.3.3 Meeting Agendas) can even be completed by the research staff after the Research Advisory Committee meeting. In any event, it would be to the Research Management Committee's benefit if the listing of projects were categorized before their review. Allocating funding can be time-consuming; this process can be much easier if there is a list to start with.

The preparation of the Research Advisory Committee requires instructional effort by the research staff. Many members of this committee are not familiar with the functioning of the agency or the research process on a state level.

It is also important that committee members appreciate the elements of the strategic plan and the agency's critical needs, if these are used as the basis for soliciting problems. These are the agency's definition of its near-term direction.

It would obviously save time at both of these meetings if the projects could be categorized by the research staff and made available before the meeting.

B.3.4 Reports

The research staff members summarize the rankings for the Research Advisory Committee meeting, prepare the minutes of each committee, and prepare the work program as approved by the Research Management Committee.

COMMENTARY:

The procedures for the prioritization process should be revised selectively, depending on the committees and groups used in the program development process.

The screening process by the research staff (Section 4.1.2.C), and the subsequent review by the Research Advisory Committee, is designed to get as much input into the early stages of the project development process as possible. Furthermore, it will provide management with the best possible technical background, which can then be weighed against other policy considerations, to develop the work program. If there are no committees for the research unit to deal with, the research unit will do the prioritizing. The text should be changed accordingly. If no committee is used for this part of the process, Problem Rating by Committee (B.3.1) can be combined with Balloting (B.3.2), as functions performed by the research staff.

The Meeting Agendas obviously apply only to those committees that are part of the process. Selective deletions should be made for committees which do not exist in the process. In addition, only the project selection aspects of a committee's functions should be included as part of the agenda. Reference should be made to Section 3.3, Research Committees, for other functions of the committees.

The last subsection of the Procedures is Reports. Again, if there are no committees set up, only that reference to the preparation of the work program is appropriate.

B.4 Schedule

The Research Advisory Committee meets in June. The location is varied to accommodate the participants. The Research Management Committee meets in July at the central headquarters.

COMMENTARY:

The interactive nature of the Research Advisory Committee meetings can be enhanced by moving the meeting location around the state. In addition, each state should set the time of the meetings to coincide with the submission of the work program to FHWA. The suggested times (June and July) would give the research unit time to prepare the necessary documents for the management meeting and modify and print the work program after the Research

Management Committee meeting. The text should be revised to refer to the research unit, if there are no committees. A schedule is still necessary without the committees.

4.2.2.C Resources

C.1 Staff

The size and abilities of research staff change over time. Because of the availability of resources outside the research unit, staff availability is not a consideration in the initial selection of projects for the work program. Staff size, expertise, and current workload determine those projects that will be conducted in house.

C.2 Financial

The financial resources accessible to the Agency to conduct research are listed in 3.2.1, Available Resources. The extent of possible categories for research are listed in 3.2.2, Categories of Research. The categories of staff research, contract research, pooled fund studies, University Transportation Center research and other shared funding research use dedicated funds, state appropriations, or another special funding source. Projects from each category are chosen from a prioritized list. Decisions on the level of funding for each category are based on management acceptance of the recommendations of the Research Advisory Committee.

C.3 Facilities

Agency facilities play a minor role in deciding on the projects selected for the work program. All other factors are more prominent. The testing and laboratory facilities of the Agency are used to the extent possible for all approved staff and contract research. When unique testing techniques are required that do not exist in the Agency, the approved project and/or task can be contracted.

C.4 Supported Agencies

The NCHRP and the UTC are two institutions that are partially supported by the Agency. Each has other financial resources that can be used to support research and each can be used as resources. The approved projects that cannot be conducted using financial resources under the Agency's control are reviewed for appropriate submission to these partially supported institutions.

C.5 Pooled Funds (National or Regional)

Approved problems considered as candidates for either national or regional pooled-fund projects are evaluated using the procedures defined in Section 4.4.3, Pooled Fund Projects.

C.6 Other Shared Funding Sources

Alliances with private industry and industry associations are sought as appropriate. The committee structure makes these contacts and discussions easier to organize.

COMMENTARY:
The list of Agency/State Needs constitutes the demand for research. The Resources form the supply available. Depending on the process used by the Agency, either the research staff or the Research Advisory Committee prioritize the demand, fit the demand to the supply and recommend a program to management.

The list of resources can be lengthy and the text is definitive in the use of each category, but the text can be changed to allow for the possibility of use of any category of resource.

4.2.3 Product

The prioritization process produces the best listing of projects that the agency can develop for the next year's research work program. The research unit has a description of priority selection in terms of agency need, a prioritization process applied to the problem statements and a match of the prioritized problems with the available resources. The problems critical to the agency are either addressed by staff, contract research, forwarded to the university centers for selection, submitted for pooled fund and NCHRP consideration, or discussed with potential partners for a shared funding arrangement.

4.3 Work Program Requirements

4.3.1 Purpose

There are many documents assembled by the research unit that help define and justify the expenditure of resources. The research work program is the single document that concisely describes all the research activities undertaken both on a technical and financial basis.

4.3.2 Process

4.3.2.A Assembling the Work Program

After the projects have been selected and approved by the Research Management Committee (Section 4.2.2.B), they are assembled with all other work program items listed in Section 4.4, for submission to FHWA for approval and authorization. FHWA approval is required for those activities using SPR funding. The work program is submitted to FHWA by September 1. This permits time for FHWA approval prior to the start of fiscal year activities on October 1.

The activities of the work program reflect all research pursuits by research staff for the period and the allocation of other research financial and equipment resources. The work program document contains all activities approved by the Research Management Committee using research resources.

4.3.2.B FHWA Work Program Requirements

On July 23, 1994, FHWA issued a final rule 23 CFR, Parts 420, Subpart B and 511, State Planning and Research Program Administration. The RD&T Work Program requirements needed to meet the FHWA regulations are defined in section 420.209 as follows:

(a) The RD&T program shall, at a minimum, consist of an annual or biennial description of activities and individual RD&T activities to be accomplished during the program period, estimated costs for each eligible activity, and a description of any cooperatively funded activities

that are part of a national or regional pooled fund study including the NCHRP contribution. The work program shall include a list of the major items with a cost estimate for each item.

(b) The RD&T work program shall include financial summaries showing the funding levels and share (Federal, State and other sources) for all RD&T activities for the program year.

(c) Approval and authorization procedures in Section 420.115 are applicable to the RD&T work program.

4.3.2.C FHWA Certification Requirements

The final rule, 23 CFR, Parts 420 Subpart B and 511, also stipulates certification requirements. They are found in Section 420.213 in the appendix of this manual. A copy of the certification will be submitted with each work program. A new certification is not required unless major changes have been made in the State's RD&T management process.

> *COMMENTARY:*
> *Although not all activities in the work program use federal funds, most states assemble one document which includes all research activities. The submission of one all-inclusive document to FHWA is a courtesy.*
> *The requirements described may be terse, but they are complete as required by FHWA and as defined in other sections of the manual. The full development of the various components of the requirements and the interaction of the research partners are detailed in other sections of the manual. A copy of 23 CFR, Part 420, Subpart B, defining FHWA requirements is in the appendix. The approval and authorization procedures can also be found there. The use of a September 1 date for the submission of the program is obviously subject to modification, based on the fiscal year of the agency. A period of 1 month is suggested for the approval turnaround time, assuming that the FHWA Divisional office has some prior knowledge of the contents of the program. Otherwise, a longer review and approval period may be appropriate.*

4.3.3 Product

The activities of the research unit are concisely and completely described in a single document. The elements of the work program describe the technical and financial responsibilities of the research unit for the term of the program. This section describes the administrative process and requirements for the submission and approval of the program.

4.4 Work Program Item Descriptions

The work program is the definitive research document. It contains all funded research or staff participation for the fiscal period. The items listed below are defined in a general sense

and the details of the Agency's staff participation is given. The work program contains these items, giving a synopsis of the activities, estimated budget, and time required to complete them.

4.4.1 TRB Research Correlation Services

Each year the Agency contributes to the general support of TRB. The contribution acknowledges that a minimum level of service from TRB is available. The support is contributed from the federal-aid SPR program allocation. The TRB general support is an established line item in the SPR Annual Work Program and is listed as "Research Correlation Services." This work program line item also supports the Agency's use of the TRB Transportation Research Information Service (TRIS) discussed in Section 4.4.8.A.2. The research unit acts as the Agency's promoter of TRB activities; Agency staff members are encouraged to participate in all TRB conferences and serve on their committees.

4.4.2 National Cooperative Highway Research Program

NCHRP is supported on a continuing basis through the contribution of funds from the AASHTO Member Departments. Annually, the Agency voluntarily contributes 5.5 percent of the funds available through the federal-aid SPR allocation. The Agency executes an FHWA PR-2.1 form, which enables transfer of federal-aid funds directly to TRB without them first having to be transferred to the State. A copy of the PR-2.1 form is in the appendix.

NCHRP was created in 1962 to accelerate research about acute problems that affect highway planning, design, construction, operation, and maintenance nationwide. Pooling of state resources enables a concerted attack on the major problems of concern to the Member Departments. NCHRP is sponsored by AASHTO in cooperation with FHWA and is administered by the Cooperative Research Programs Division of TRB.

The AASHTO Standing Committee on Research (SCOR), with input from the Research Advisory Committee (RAC), is responsible for the program. NCHRP addresses the full spectrum of highway transportation technical areas. The program categorizes problems into eight research fields and subdivides these fields into 25 technical problem areas. These are shown in Figure 1 in the appendix.

The important dates of the Program Formulation Cycle are as follows:

- May 30 — Deadline for First Stage Problem Statement Submittals by AASHTO Member Department
- October 31 — Deadline for Second Stage Problem Statement Submittals.
- April — SCOR recommendations are forwarded to AASHTO for Member Department approval through ballot; approved program referred to TRB, Cooperative Research Programs Division, for administration.

NCHRP Publications include the following:

- *NCHRP Reports*: publications documenting selected research performance, findings, and conclusions. NCHRP reports are a formal series and issued by number.

- *NCHRP Syntheses*: a compendium of reports of the best knowledge available on the practices found to be the most successful in solving specific problems. These reports are not as detailed as the NCHRP Report series. Syntheses are also issued by number.

- *NCHRP Research Results Digests*: timely newsletter-format documents used to convey research findings before the completion of a project.

- *NCHRP Legal Research Digests*: papers compiled in a newsletter-format on pertinent legal issues.

COMMENTARY:
NCHRP is the cooperative research program for state agencies, and each state agency is welcome to take maximum advantage of it. Agencies (AASHTO Member Departments) participate in NCHRP through voting on the program presented by SCOR and by SCOR membership, through project panel membership, and, most importantly, through submission of research problem statements. It is particularly advantageous for a state agency to refer a nation-wide problem to NCHRP. Because of the highly leveraged funds, the agency pays only a fraction of the cost of the research and receives the results of the full research effort. To assist in having a problem accepted, it is productive to determine if other states are interested in the problem and to jointly submit or submit individual statements with appropriate references to the other problem submissions.
Because of the consensus process among the 52 AASHTO Member Departments, NCHRP research studies may require a longer lead time to initiate the project and a longer time for approval of publication. These time factors should be considered when proposing problems for the Program. Often the research may be performed in less time by one state agency, but the cost for major studies may not be feasible for one agency to bear, thus the cooperative arrangement is beneficial for all.

4.4.3 Pooled Fund Projects

4.4.3.A FHWA National Pooled Fund Program

FHWA sponsors a National Pooled Fund Program. A letter describing the proposed pooled fund projects is distributed to each state research unit manager. The research unit manager is responsible for soliciting opinions and comments from technical staff within the agency regarding the relevancy of the pooled fund project to the agency's needs. If the agency determines that it should participate in a project, the research unit (along with other technical

staff) determine the amount of financial support the agency will give to the project. The FHWA regional research engineer is responsible for getting the state to execute the funding transfer documentation, a PR-2 form. A copy of the form is in the appendix. The project may be performed by FHWA technical staff or by contract.

As a subscriber, the state may have a representative on the project panel that meets to determine the scope of work for the project, to evaluate proposals if the research is performed by contract, and to review the final report of the effort.

The total amount of annual pooled fund financial support is a line item in the SPR budget.

> *COMMENTARY:*
> *Recently FHWA prepared a Draft Pooled Fund Procedures document. The procedures deal with national and regional pooled fund studies.*

4.4.3.B Regional Pooled Fund Program

FHWA sponsors a Regional Pooled Fund Program, which is more of a bottom-up program than top-down as is the national program. A group of states may determine there is a problem of mutual interest to them. To begin a regional pooled fund project, the state DOT that champions the idea usually performs the initial and ongoing administrative duties. This state research unit then coordinates with the FHWA Regional Research and Technology Engineer, who assists with soliciting study subscribers and with the funding process. The administration and research may be contracted. Each regional pooled fund effort varies in its financial protocol, which is usually based on the requirements of the lead state.

Although federal-aid funding of pooled fund efforts is at the traditional 80-percent level, if the project is determined to be of national interest, the FHWA Associate Administrator for Research and Technology may determine that the project is a 100-percent federal-aid funded project. Most regional projects are funded at the 100-percent level. As with national efforts, reimbursable travel funding may be included in the study funds.

> *COMMENTARY:*
> *Recently, FHWA prepared a Pooled Fund Procedures document. The procedures deal with national and regional pooled fund studies.*

4.4.4 Experimental Projects

Field trials of the products of research are important and demanding because these trials are performed generally under normal traffic conditions and with a variety of environmental conditions. Although field trials are vital, the products used are non-standard. The potential impacts of new installation procedures or premature deterioration of the products require special consideration.

The research unit has several ways to support field trials and evaluate experimental products. One method is through the FHWA Experimental Projects Program.

The FHWA Experimental Projects Program enables the Agency to conduct laboratory and field evaluations of new or innovative materials if the product or concept has not been the subject of previous research or is a solution for a current problem experienced by the agency. The research unit coordinates and monitors these projects when products are incorporated into federal-aid construction projects. Funding for the performance evaluation is provided through issuance of a work order under the existing federal-aid agreement. The Agency ensures that the installations conform to accepted principles for experimental projects which include the following:

- Incorporation of adequate lengths for test sections and replications for the experimental feature;
- Installation of control sections of standard design against which the experimental feature can be compared;
- Taking precautions to ensure that the results are not biased by the site-specific conditions such as differential traffic volumes, topography, or other environmental factors.

These experimental projects normally require formal documentation, including a construction report, periodic field survey and performance reports, and a final report. The results of these experimental projects are directly applicable to the Agency. The information contained in these reports may also be of use by other state DOTs or other transportation entities. To enhance the application of these results, FHWA compiles a list of all of these reports, from all state DOTs, and makes the list available annually.

Experimental projects may be coordinated, evaluated, and monitored by the research unit personnel, or funds from the research budget may be transferred to a unit responsible for performing the experimental project. Funds to support the FHWA program are contained as a line item in the SPR program budget. Regardless of which unit is responsible for the performance of the experimental effort, research unit managers incorporate the funding requirements in the SPR budget estimates.

4.4.5 University Transportation Center Program (UTCP)

The U.S. DOT established the University Transportation Centers Program (UTCP) in 1987. The originating legislation established ten regional centers, and ISTEA added three additional national centers.

The goals of the UTCP are as follows:

- Provide interdisciplinary education in all modes of transportation to tomorrow's professionals and to advance the skills of today's professionals;
- Address current and future transportation challenges and issues through applied, interdisciplinary, and basic transportation research covering all modes of transportation; and

- Disseminate the results of the research through carefully planned programs of technology transfer and early involvement with the prospective users of the products of the research.

The legislation provides federal funding for the centers on an annual basis, but these funds must be matched by non-federal monies. The Agency can be a source for matching research funding for the UTC. Should the appropriate research projects be defined, the research unit could receive twice the effort for the funding it contributes.

> *COMMENTARY:*
> *Although this is an excellent way to take advantage of research funds—a significant problem for many research units is the scarcity of non-federal funds for research.*
> *If funds are available, this is an advantageous program for any research unit. Funding a UTCP project may provide a research unit with the opportunity to initiate some basic research that it would otherwise not be able to perform. In addition, the program may allow the research unit to support research in transportation modes and disciplines other than what can be done with in-house staff expertise.*

4.4.6 Local Technical Assistance Program (LTAP)

The Local Technical Assistance Program (LTAP) is a high-profile technology transfer program sponsored by FHWA. The program, established in 1981, encourages cost-effective improvements to roads and bridges owned and maintained by local government.

Federal-aid LTAP funds are available for 50 percent of the program funding; the state and the LTAP Center provide the match. Through training courses, production of users' manuals, on-site demonstrations, and a strong network of technical expertise available to the local governments, the program furthers the implementation of highway innovations at the local level. The funds available and the people-intensive focus enable new processes, methods, and other innovations to be more easily applied to local highway practice.

The LTAP Center is located at the state university, staffed by non-Agency personnel. The research unit functions as a program administrative director and technical advisor. The Center provides proposals of work for the coming performance time frame and is awarded funds based on the proposals. The Center has a close association with agency technical personnel, who facilitate the flow of technical information to the Center and its customers.

> *COMMENTARY:*
> *LTAP has been and continues to be a very useful technology assistance program. It is important to assign sufficient resources for agency management of the program.*
> *Although the text indicates that the Center is at a specific university, the actual site for the Center should be stated in the text.*

A recent report on the Centers' activity and performance estimates that 45 percent of the eligible local governments are taking advantage of the programs' services. The report also states that, in 1988, the Centers realized a return of $9.00 for every dollar invested in the program. LTAP bases much of its service on personal contact/one-to-one interaction. Each Center operates with an average of five part-time employees.

4.4.7 Strategic Highway Research Program (SHRP) Implementation and Long-Term Pavement Performance (LTPP)

The FHWA Office of Technology Assessment (OTA) undertook the continuation efforts for the Strategic Highway Research Program (SHRP) implementation activities. Implementation packages are prepared by FHWA for various SHRP products. These "showcase" products are available to the agency. The state has an aggressive effort to implement the products of SHRP, purchase equipment, conduct pilot and experimental projects, and initiate internal task forces to assist with the implementation effort.

The research unit has the responsibility to oversee the agency's SHRP implementation efforts. The SHRP Implementation Coordinator in research is the contact point within the agency for all SHRP implementation activities. The SPR Work Program has a line item for implementation activities.

The Agency is also conducting research on the Long-Term Pavement Performance (LTPP) module of SHRP. Test sections were installed in many locations; the agency is monitoring and evaluating the performance of these sections. The research unit funds these LTPP SHRP activities out of SPR money.

COMMENTARY:
SHRP and LTPP activities vary by state—the text should be changed accordingly.

4.4.8 Technology Transfer

The research unit performs technology transfer activities for the Agency and transfers the technology developed through the efforts of the research program. A few methods used by research to transfer technology are as follows:

- Training Course—either developed in conjunction with a specific research project or through the National Highway Institute or other education and development avenues;
- Agency Library—an extensive collection of transportation-related literature and capabilities for data search and retrieval (for research as well as the agency);
- Report and Publication Distribution—research reports and other materials generated by RD&T activities;
- Research Project Results and Status—input to TRIS database;

- Executive Summary Services for Research Reports—short summaries of extensive research reports containing sufficient information for the reader/user to understand the basic principles and recommendations of the research; and
- Promotion of seminars, conferences, exhibitions, and other opportunities for disseminating research results materials, either in-house or outside of the agency;

The research unit performs or coordinates technology transfer activities and encourages others in the agency to participate in them. Research funds are often used to fund these activities when they are performed for operating units in the agency.

COMMENTARY:
The research unit manager who is responsible for technology transfer activities within the agency must budget appropriately for this effort. SPR funds may be used for such items; some planning monies may also be available for training, and potentially state funds as well. Regardless of the funding source, research units must reserve appropriate resources, staff, and money to accomplish this very important aspect of RD&T efforts.

4.4.8.A TRB

TRB is a unit of the National Research Council, which is the principal working arm of the corporate institution that includes the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

TRB began in the early 1920s as the Highway Research Board. The Board's name was changed in 1974 to the Transportation Research Board in recognition of its broadened approach to transportation problems. TRB's purpose today is to bring scientific and technical knowledge to bear on transportation problems by encouraging and conducting research and disseminating information in the following areas:

- The planning, designing, construction, operational aspects, safety, and maintenance of transportation facilities and their components;
- The economics, financing, and administration of transportation facilities and services; and
- The interaction of transportation systems with one another and with the physical, economic, and social environment that they are designed to serve.

A.1 TRB State Representatives

The research unit represents the Agency to provide liaison with the Board. A designated representative informs the Agency of TRB activities, receives all TRB publications, and advises TRB of current and contemplated research activities of the department.

General responsibilities of the TRB State Representative are as follows:

- Maintain an awareness of general procedures concerning the operation of TRB committees, NCHRP, Transportation Research Information Service (TRIS), and other special activities;

- Keep others in the Agency and other related state agencies informed of TRB activities;
- Recommend qualified people for membership in TRB committees and panels;
- Update and submit selective distribution forms for TRB publications annually;
- Update and return the information services (TRIS) summaries of ongoing research projects, and report initiation of new research;
- Supply TRB copies of the Agency's research reports and other reports of research as appropriate;
- Coordinate responses to TRB-initiated solicitations and questionnaires;
- Assist TRB staff members in scheduling meetings with agency personnel during field visits;
- Submit items for consideration for the *TRNews*; and
- Encourage Agency personnel to submit papers for presentation at TRB meetings and for publication.

COMMENTARY:
The TRB State Representative is the individual within the state who is responsible for facilitating the execution the TRB/agency contract and who receives the notice of amount of funds to support the TRB Correlation Services (see Section 4.4.1). The amount of this allocation is a line item in the SPR Work Program annual budget.

A.2 TRIS

TRB maintains and operates the Transportation Research Information Service, a computerized information storage and retrieval system that contains over 400,000 abstracts of published transportation research articles and reports and summaries of ongoing research projects. The AASHTO Research Advisory Committee Research-in-Progress database is incorporated into TRIS.

The research unit searches the system directly via AASHTO-VAN online services or indirectly by making requests through the TRIS staff. Other services, such as topical searches, are provided upon request. In addition, project summaries and abstracts of completed transportation research appear periodically in various TRB publications.

COMMENTARY:
State DOTs are sponsors of TRB, and there is no charge for requested TRIS staff-performed literature searches. TRIS services are available on a fee basis for persons or organizations not affiliated with TRB. Information regarding access to TRIS is readily supplied by TRB; on-site presentations may be arranged for agency personnel to enhance their skills in the use of TRIS.
The use of TRIS is required by the FHWA SPR RD&T Program Management Process. State research units must use the TRIS database for program development, reporting of current RD&T activities, and input of the final report information. It is desirable

that a TRIS search be performed for each problem considered for research by a state agency. Such searches help prevent duplication of research effort and in coordination of efforts among various agencies interested in the same topic.
TRIS is a unique service within the transportation community; it is a primary tool for researchers reviewing the body of literature on specific transportation topics. TRB has experienced personnel to perform searches or to offer technical support for new and current users. Requests to TRB personnel for searches may be done by telephone, fax, or in writing. TRIS maintains records on completed research and is working on enhancing its database to include research in progress.
TRIS is also available through the Internet.

A.3 Library

The TRB library provides the Agency with access to an extensive collection of transportation literature and provides assistance in locating information available in other libraries. The library is located in the TRB offices.

COMMENTARY:
Although many agencies have a library, the TRB facility is available for agencies to use. Many agencies' librarians use TRB as an additional resource for information. It is advisable to have one or only a few points of contacts within a state to deal with the TRB library. Walk-in service and telephone requests are available to TRB members at no cost.

A.4 TRB Publications

TRB distributes a variety of publications. As a member state, the Agency receives a full complement of the publications. The TRB state representative receives these publications and is responsible for informing TRB of the needs and changes for future publications. TRB annually asks the state representative for an update to the publication distribution.

In addition to NCHRP publications described in Section 4.4.2, TRB publishes the following:

- *TRNews*, a bimonthly magazine of TRB and transportation community activities;
- The Transportation Research Record series, documenting research papers presented at the TRB Annual Meeting in January each year;
- The Transportation Research Circular series, documenting presentations and committee activities; and
- Major policy studies and other special projects conducted through the work of project committees, staff, and consultants.

COMMENTARY:

Publications from TRB are valuable sources of information for the research unit. Ideally, publications should be circulated among the research staff. Publications should be accessible to researchers and others within the agency. A reference collection of the publications is helpful, whether located in the agency library or the research unit.

4.4.9 Implementation Activities

The research work program, and particularly the SPR work program, may contain an implementation effort as a discrete item. The research unit includes funds in its budget for implementation of research findings, because it is uncommon for research findings to be put into practice without additional cost or effort. The availability of implementation funds can immediately remove financial barriers that might otherwise prevent implementation of an innovation. Implementation monies can be used for some aspects of technology transfer and other appropriate activities fostering the adoption of research findings.

As noted in Section 9.0, Implementation Process, funds are programmed for staff, facilities, testing, adaptation, packaging, and promotion of new technology, particularly if a large-scale effort is expected.

COMMENTARY:
It is in the research unit's best interest to attempt to remove as many barriers as possible to the use of research findings. Generally it is more costly to implement new products or processes than anticipated, so having funds for implementation is at least a "head start." Often funds are budgeted in one lump sum—one budget line item—and then used on various projects throughout the budgeted time frame.

4.4.10 Peer Exchange Process

In conjunction with the FHWA RD&T Program Management process, peer exchanges of Agency research units may be made once every 3 years. Sufficient resources are set aside under this line item in the work program to provide for the peer exchange of the Agency's research program and the time requirements of serving on an exchange team to another state.

COMMENTARY:
Modify funding and other descriptive information as it may change with regulations.

4.4.11 Staff/Contract Projects

Staff and contract projects make up most of the research unit's activities. Projects are selected for performance within each work program. The research unit lists the anticipated

projects to be initiated in the coming year and usually gives an estimated project cost and time for completion. In addition, the work program contains descriptions and status reports on research-in-progress.

The research unit performs research either with the unit staff or contracted researchers from academia, research institutes, other non-profit organizations, and the private sector. Each project in the work program includes the performing organization, such as the research unit or agency staff or contract organization, and the principal investigator.

A project number is assigned to each research project. The numbering system is designed by the research unit and communicates such items as the year the project was initiated, staff or contracted research, and type of project (e.g., research, experimental, demonstration) or funding source.

4.4.12 Administration

The work program contains the necessary funding to support administrative activities. The administrative costs include fringe benefits, overhead, labor for all staff members, and direct salary for staff administrative functions (i.e., clerical, secretarial, financial, procurement/contract, and other similar labor costs). Direct costs, such as staff training, non-project specific travel, facilities and upkeep, supplies and equipment not chargeable to projects, and other non-project specific costs, are part of the overall administrative costs.

COMMENTARY:

Research work programs include the effort and cost of performing the research as well as the resources required (staff effort) and other direct costs of administrative support for the research activities.

Administrative activities and their costs are needed in order to "do the business of research" for the agency. The more spent on administrative costs, generally, the less available for the actual research. However, this concept cannot be carried to the extreme. Research requires a considerable amount of administrative support. Without the support, highly paid technical experts do not work to their optimal levels. Resources are wasted, and maintaining a stable level of technical expertise is often jeopardized, because researchers may not be sufficiently challenged or directed.

Administrative costs are usually a line item in the research unit budget. It is a continuing challenge for the research unit manager to stay within the budgeted costs for administration.

SECTION 5.0 PROJECT DEVELOPMENT

5.1 Project Work Plan Preparation

5.1.1 Purpose

A project's research effort is defined in its work plan. A concerted effort in preparing work plans assures focused objectives, improved research, and a high potential for implementation of the project results. Focused objectives save resources and time. Improved research maintains credibility in the performance of the research team and their results. The potential for implementation sustains interest, enthusiasm, and a desire to induce change.

> *COMMENTARY:*
> *In general, a work plan is either Agency-prepared or contractor-prepared. The latter is in response to an RFP. In contract research, most states negotiate a scope of work with a contractor. The Agency may use any combination of methods, particularly if, in addition to staff work, contractors are used to accomplish the research. Because most agencies conduct staff and contract research, the Process is written to permit the simultaneous use of both methods.*

5.1.2 Process

Agency operating staff, by incorporating their opinions and requirements, play a prominent role in preparing the project work plan for research conducted by staff. The research unit ensures that all appropriate components are contained in the work plan. For projects accomplished by contract, an RFP describes the information required.

5.1.2.A Participants

The Project Committee (Section 3.3.2.C) works with the research unit and the principal investigator to involve all appropriate disciplines in the preparation of the work plan for staff research and in the preparation of the RFP for contract research.

A.1 Agency Operating Staff

Most research projects respond to the needs of the operating units of the Agency. Staff from those units participate in the Project Committee and provide a very important contribution in meeting research objectives.

A.2 Suppliers/Contractors

When appropriate, material suppliers or construction contractors are also included in the work plan preparation and may become members of the Project Committee. The success of the research and the implementation of the results may depend on construction techniques and the availability of materials before specifications are developed.

A.3 FHWA/Regional Agencies

Representatives from FHWA Divisional and Regional offices also contribute to the work plan and offer regional and national perspectives on research in other states. Regional transportation agencies are asked how the project affects their operations.

A.4 University Staff

For Agency-prepared work plans and RFPs, appropriate expertise is sought from universities. The only limiting factor to selecting academics is a potential conflict on contract research. No proposals are accepted from members of the Project Committee.

> *COMMENTARY:*
> *In preparing the work plan or RFP, there may be reason to exclude some of the suggested participants. The foregoing participant list is intended to be as comprehensive as possible. Careful selection of participants ensures that necessary parties are included, appropriate experts are involved, and conflicts of interest do not arise.*

5.1.2.B Components of Request for Proposals (RFPs)

All projects advertised for contract have the following information.

B.1 Project Title

The problem title should be concise.

B.2 Statement of Problem

Current operations of the Agency are thoroughly described and defined to highlight the existing problem.

B.3 Research and Implementation Objectives

The conditions that the Agency wants to exist after the successful completion of the research are listed. A generalized statement of the implementation process is given. Some advertised projects may include a general list of tasks that the contractor is expected to respond to in detail.

B.4 Study Time and Cost Limits

Because the Agency needs timely research results, deadlines for completion are stated in each proposal. For some projects, a limited budget allowance will be stipulated. Otherwise, cost estimates are not given.

B.5 Administrative Requirements

Administrative concerns must be satisfied by a proposal. Responding contractors are required to include the following:

- Type, content and frequency of project reporting
- Frequency of project meetings
- Contractor's use of subcontractors, particularly minorities
- Submission of the appropriate number of copies of the proposal
- Date of submission of the proposal.

B.6 Proposal Submission Requirements

Many of the following items in the submitted proposal are defined in Section 5.1.2.C, Components of Project Work Plan for Staff Research:

- Detailed statement/understanding of the problem;

- Summarized history of problem background and an understanding of how the problem affects the Agency;
- An essay on the objectives of the research;
- Detailed work plan showing individual tasks;
- Complete schedule by task;
- List of all lab, testing, and computer facilities available to the contractor;
- Details of the project budget, including staff salaries, fringe benefit and overhead rates, subcontractors, travel, equipment, and any other major item;
- Resumes of principal staff;
- Availability of principal staff during the term of the contract; and
- Concise description of the pertinent experience of the organization.

COMMENTARY:
In addition to the listing above, an agency may have unique requirements that must be in the RFP. These can be added to either the administrative or submission requirements.

5.1.2.C Components of Project Work Plan for Staff Research

The principal investigator of the research unit is responsible for developing the project work plan. The research unit serves as the working arm of the Project Committee and ensures that all components of a project work plan are included. The principal investigator makes the information gathered by the screening process (4.1.2.C) available to the Committee for appropriate review of the work plan.

C.1 Project Title

The title for the project should be short but descriptive enough that anyone scanning a list of titles will not be misled.

C.2 Statement of Problem

It is necessary to give a complete description of the problem and its effects on the operations of the Agency. An explanation of the inadequacy of a technique, material, or specification can define the extent of the problem.

C.3 Problem Background

The conditions that currently exist must be defined and all known research on the issue summarized. A history of the condition provides knowledge and important background for the development of the work plan.

C.4 Study Objectives

The objectives define the conditions that are expected to exist at the completion of the work. These conditions are described by goals that give the optimum technique, material, or specification from a financial, operational, environmental, or social viewpoint.

C.5 Plan of Work

The plan of work demonstrates an understanding of the techniques and method to be used to resolve the problem. The work plan must contain all components necessary for the successful completion of the research, including updating the state of the art; design of the research experiment; lab, testing and computer facilities; data collection elements and procedures; analytical procedures; notation of key decision points; schedules of meeting; and reporting details.

C.6 Implementation Statement/Project Benefits

The process used to implement the research will be outlined. Because of the potential for change in the research strategy, detailed definition of the implementation process is not given in the work plan. Qualitative benefits of successful research should be stated.

C.7 Work Schedule

The schedule of tasks of the work plan components, listed in C.5 above, include both calendar time to accomplish the task and staff hours per task. Milestones and decision points are also shown.

C.8 Cost Estimate

Each component of the work plan represents estimates of salary, equipment, travel, and miscellaneous costs. For example, components show the following:

- Wages for investigators, technicians, and support staff;
- Fringe, administrative, and indirect charges;
- Equipment needs;
- Travel costs;
- Miscellaneous expenses; and
- Subcontractor costs (itemized above).

COMMENTARY:
Although both staff research and contract research have work plans, their requirements and methods of preparation differ. Section 5.1.2.B gave the requirements for an RFP, the response to which is a contractor proposal that is essentially a work plan. Section 5.1.2.C concentrates on staff research project work plans. Common elements are listed, but there may be unique requirements that agencies may need to include.

5.1.3 Product

The project work plan defines the tasks of the research project. The components of the work plan are defined so as to achieve an implementable product. The requirements of a project work plan and an RFP help ensure an appropriate in-house research effort and contractor response. The participants, RFP elements, and work plan elements enable all parties to examine and improve the plan.

5.2 Staff Research Project Development

5.2.1 Purpose

It is in the Agency's interest to retain staff and enhance their expertise. One way to do this is to conduct appropriate in-house research. Functional areas of research are consciously chosen in which staff can develop expertise. Research staff are continuously and thoroughly trained and required to keep abreast of the developments in the selected areas to form the nucleus

of Agency expertise. Support from the operating units of the department complement the Agency's abilities. .

COMMENTARY:
Staff research selection and project development are important to the perpetuation of the agency's ability to have staff respond to basic agency needs. Agency staff expertise is a valuable resource for day-to-day operations. This expertise enables staff to scrutinize contract research work, provide information on current technology and practice, and develop research need statements.
Application of this section depends on the agency's use of staff research. The intensity of the agency's input to the project objectives depends on the process used to develop a project. Staff research implies the active participation of the agency in developing the objectives for all projects.

5.2.2 Process

5.2.2.A Research by Functional Area

The functional areas of the department are considered basic for developing Agency research. Staff and contract research is fostered in the following:

- Administration—personnel and procedures;
- Bridge design—innovative structural and deck design and bridge management ;
- Commercial vehicle operations—freight movements;
- Construction techniques—innovative contracting practices;
- Environment—air, noise and water quality, recycling, and waste;
- Information technology—literature dissemination;
- ITS—traffic information and management systems;
- Intermodal operations—passenger and freight movements between modes;
- Maintenance—maintenance management;
- Materials—asphalt and concrete mixtures;
- Pavement design—techniques and mixtures;
- Planning—modelling and forecasting techniques and congestion management;
- Policy issues—management decisions;
- Safety—traffic and roadway;
- Surface design—pavement management and safety-related geometric design;
- Traffic—traffic flow and system improvements; and
- Transit issues.

5.2.2.B Research Objectives

The goals and objectives of research in each functional area listed in Section 5.2.2.A are determined by the operating units of the Agency based on the strategic plan. Although staff perform many roles, research performed by staff takes three general forms. These are described in Section 6.0, Conducting and Monitoring Research Projects, and include the following:

- In-house research,
- Technology transfer efforts, and
- Monitoring of contract research.

5.2.2.C Development of Staff Project Work Plan

The work plan for staff research is developed by the researcher given responsibility for conducting the project. See Section 5.1.2.C, Components of Project Work Plan for Staff Research. This activity is undertaken in collaboration with the Project Committee and the submitter of the problem statement. Review material amassed under 4.1.2.C, Problem Screening by Research Staff, is available to the researcher and the Project Committee to complete the work plan.

> *COMMENTARY:*
> *The strategic plan covers current focus areas in which the research unit concentrates activities.Other items can be included by an agency in this list.*
> *Reference made to the strategic plan should be replaced by the appropriate method used by the agency to highlight needs, such as critical needs and agency needs.*

5.2.3 Product

With the development of staff research, members of the research unit are given the opportunity to advance their professional stature. The extent of functional areas in which staff expertise is to be developed is itemized in this section. Strategic plan updating may modify this list.

5.3 Contract Research Project Development

5.3.1 Purpose

Contract research is needed when there is the lack of available staff or expertise in the research unit, the research to be performed is more complex than staff can handle, or an objective opinion outside the Agency is needed. The contractor is important in defining the exact nature, objectives, and scope of a research project. The role normally performed by research staff in the development of a project work plan is accomplished by a contractor with the submission of a proposal.

The goal to achieve implementation is also important with the use of a contractor.

5.3.2 Process

5.3.2.A Selecting a Contract Program

Research problem review material is prepared by research staff (4.1.2.C, Problem Screening by Research Staff) and submitted to the Research Advisory Committee for consideration. The Research Advisory Committee recommends the actual projects to be contracted

and the contract agent (6.2.2.A, Contract Research Agents). The Research Management Committee has the final approval of the program. The decision to contract projects is based on research staff availability and expertise, the perceived complexity of the research, or the desire to have an objective opinion outside the Agency.

5.3.2.B Solicitation of Contractors

The research unit prepares the RFP, according to Section 5.1.2.B, Components of RFPs, for each of the projects selected to go to contract. The RFP is distributed to select State universities and private consultants. The proposals received in response to the RFP contain the information noted in 5.1.2.B.6, Proposal Submission Requirements.

COMMENTARY:
Many states submit an RFP only to select university academics. Private consultants are not used. The text should be altered to reflect this solicitation method.

5.3.2.C Developing A Contract Project Work Plan

The contractor develops a work plan for the project, according to Section 5.1.2.B, Components of RFPs. This work plan is part of the proposal. If selected, a contractor may modify the work plan in consultation with the Project Committee.

5.3.2.D Selection of Contractor

The Project Committee performs a technical and budgetary analysis of the submitted proposals. Further expertise to evaluate proposals is added to the committee, as necessary.

The Project Committee conducts the technical evaluation using Form 5-3 in the appendix. The Project Committee weights each criterion. Because each project is unique, each will have unique criteria. The three highest-rated proposals are recommended to the Research Management Committee (Section 3.3.2.D).

After the Research Management Committee selects a proposal, it is subject to a budgetary analysis by the Project Committee. The analysis includes a review of the estimated cost of individual project tasks and any agency research or budgetary constraints. The Project Committee reviews comments on the technical and budgetary aspects of the proposal and differences are reconciled with the first-ranked contractor. If differences cannot be reconciled, the second-ranked contractor is engaged for contract discussions.

COMMENTARY:
Some states may select the contractor and conduct the review process in a different way than stipulated above. For instance, upper cost limits may be specified in the RFP, the review team may only recommend one contractor, or a different committee may review the proposals and make recommendations. The text should be altered accordingly.

5.3.2.E Negotiating Contracts

The Project Committee takes the lead in negotiating the scope of work, deliverables, schedule, and budget terms of the contract. The research unit coordinates contract negotiations.

COMMENTARY:
Each state has its own procedures for negotiating and setting terms for contracts. This section should specify exactly the Agency terms for negotiating with a contractor.
The methods used in each of the sections, from Selecting a Contract Program to Negotiating Contracts, vary by state. The NCHRP Synthesis 231, "Managing Contract Research Programs" gives more specific information on each state's process. The text presumes that the research unit is an active participant in each step of the process. Modifications must be made by the individual state to accommodate its own process.
All steps of the research process up through the point of negotiating the contract are included. Not all steps are followed by all states. Some states have developed special agreements with the universities within their state's boundaries; these agreements define the contractual procedures. These procedures need to be written into the manual.
If universities play an active and primary role in developing the research projects, each of the subsections in the Process should be modified to reflect this involvement.

5.3.3 Product

The delivery of research products must be ensured even when work is accomplished by contract. Every step of the contract research development process must be understood and defined, including selecting the program, soliciting and selecting the contractor, developing the work plan, and stipulating the requirements of the contract. The process stresses the importance of spending the effort on all contract and project details to avoid contractor misunderstandings during the course of the work.

SECTION 6.0 CONDUCTING AND MONITORING RESEARCH PROJECTS

6.1 Conducting Staff Research

6.1.1 Purpose

In general, the range of research staff functions is more extensive than other units in the agency. One of these functions is performing research on projects, as determined by the Research Management Committee. Although this is the most time-consuming activity, it is also one of the most rewarding and is necessary for maintaining staff expertise. Another function is the transfer of technology. Research uncovers facts in a specific field in order to apply the results. Technology transfer activities help implement research effectively.

This section of the manual describes daily tasks performed by staff. Although other sections address similar functions, the stress is usually on the research process and not on daily operations.

> *COMMENTARY:*
> *The size of the research unit in a state may not permit some of the activities listed below to be effectively handled by staff. In fact, staff research as a function may not exist. For those states that solely conduct a contract program, not all of the material presented in Section 6.1 is applicable. States may want to incorporate some of the suggestions in Section 6.1.2 A, even if there is no in-house research program. The section on Conducting Staff Research provides staff guidance on conducting daily activities. Even without an in-house research program, the technology transfer activities of staff are sufficient to warrant an extensive description.*

6.1.2 Process

Several work activities in each of the primary tasks are performed by research staff. Expectations of staff performance regarding each of the work activities are outlined below.

> *COMMENTARY:*
> *Most states perform staff research. The variations in work activities and procedures between the states may be extensive. The following items cover most of the staff research activities. The exact nature of staff operations should be altered to fit state conditions.*
> *This section is presented as a procedure manual for staff; the rest of the manual generally covers the research process as others are affected by it and involved in it.*
> *Staff within the research unit must understand procedures for their work conduct. Although there may be many administrative*

procedures that govern all agency staff , this section covers the operations specific to the research unit.

6.1.2.A In-House Research

A.1 Contact With Client

The Project Committee, Section 3.3.2.C, specifies the function, membership, and agenda for the committee that provides primary guidance to research staff in conducting a project. Research staff are encouraged to maintain close, frequent contact with the committee.

A.2 Contact With Supervisor

The research supervisor manages and controls staff activities. Staff should notify their supervisors of the following circumstances:

- Failure or difficulty in a project,
- Unexpected or unexplained results or findings,
- Scheduled meetings or presentations on the project,
- Change in project direction suggested by members of the Project Committee, and
- Uncertainties about activities or project direction.

A.3 Supervising Staff

Techniques for supervising staff are described in Section 12.1, Staff Training and Education. Encouraging and allowing staff to develop while objectives of the project are advanced are the basic principles of staff supervision. The level of supervision required depends on staff abilities. Trained staff are qualified for their assignments and usually can succeed without close supervision; staff in the training mode require closer supervision.

A.4 Data

Data collection methods vary with the research project. Techniques to be used for different research designs are shown in Section 12.1, Staff Training and Education. If statistics or measurements are used to develop findings for the project, the experimental design (approved by the Project Committee) serves as an excellent base to determine appropriate conditions, equipment, time intervals, frequency of collection, and laboratory analysis techniques.

Errors in the data can occur at any step of the process. Care must be taken to ensure that the data collection conditions and equipment are thoroughly checked at all steps in the process.

A.5 Tracking Project Costs

Costs associated with the conduct of in-house research are shown in the quarterly report (Form 7-1 in the appendix). They are itemized as staff, overhead, travel, equipment, and miscellaneous. In addition, a Project Task Completion Schedule is prepared for each project (Form 6-1 in the appendix). The Project Committee and the research manager confer on expenditure deviations and time overruns from those programmed. Recommendations for project modifications are made by the manager to the researcher.

A.6 Maintaining Records

It is extremely important to maintain well-ordered project correspondence and project data. The credibility of staff and the research depends on these documents. Project correspondence is maintained in the central filing system of the research unit. Research staff members have unimpeded access to these files, but others must access files through the clerical staff. Except for copying purposes, files cannot be removed.

Generally, collected data are maintained on electronic media (e.g., diskettes). Whether manually or automatically collected in the field, lab, or from other files, data are carefully recorded on permanent project records. The data and all steps in the handling of the data are checked by other staff. The data analytical techniques used in the research project, and referred to in Section 12.1, Staff Training and Education, are also checked by other staff. Records are kept of the collecting and checking procedures.

A.7 Presenting/Reporting Results

During the research, individuals or groups may ask for preliminary results or findings. All presentations of preliminary research must receive approval by the research manager, the client (who comes from the ranks of the research partners described in Section 2.4.2.A), and the Project Committee. Methods of presentation are determined by the principal investigator. Graphic displays are encouraged.

The principal investigator develops and disseminates formal research reports on a timely basis. Section 7.0, Program Reporting, details various types of research unit reports, their content and their reporting frequency.

A.8 Scheduling and Conducting Meetings

Various meetings are held during the course of a research project.

Meetings of project staff are the most common and frequent. They require the least notice and are held at the discretion of the principal investigator. All technical and administrative aspects of the research, personnel, and project work conditions are discussed at these meetings.

Project Committee meetings are the next most frequent. These are called at the discretion of either the principal investigator or the project committee chairperson. Discussion of project progress, problems, and findings are the usual items for discussion at these meetings.

Project-specific Research Advisory and Research Management Committee meetings are arranged infrequently by the research manager. Attendance at the meeting is usually determined by the research manager. The agenda may include a presentation of the findings or serious impediments to the research that require resolution by the committee members. Such meetings may not be necessary for every research project.

Special meetings may involve the Agency's commissioner and industries or citizens affected by the research. They may be suggested by the principal investigator, commissioner, or a non-agency group and are convened under the research manager's direction. Government policy or matters sensitive to affected groups are usually discussed.

COMMENTARY:

Considerations, such as the size of the research unit, the policies of the agency, and funds available for the research program, determine the magnitude of the in-house research program. The nature of the research performed determines the extent of the data collection requirements, record maintenance, reporting, and meetings.

Data collection has several forms. Reference to Section 12.0, Program Management, should be reviewed because all data collection procedures will be discussed in it.

Section A.6, Maintaining Records, should be as comprehensive as appropriate.

It is generally understood that cyclical and final reports are prepared, but impromptu presentations can be important to the implementation efforts of the project and should receive careful consideration.

In the following discussion on meetings, the content of the meeting is noted but the format is left open. There are several methods of holding each of the suggested meetings; the method selected should be left to the discretion of the research manager.

6.1.2.B Technology Transfer (T^2) Efforts

B.1 Uses For T^2

Technology transfer activities are described in Section 4.4.8 (as an item in the work program), Section 8.0, Technology Transfer, and Section 9.0, Implementation Process. They are also discussed in sections of the manual where they affect a procedure.

The primary objective of technology transfer is to determine the status of transportation problems and solutions and transfer the latest findings to practitioners. Staff accomplish this by performing activities defined in B.2 through B.7

B.2 Information Sources

The research unit uses TRIS either through a direct computer link-up or remotely. Details of how the system is used are given in Section 8.3, Information Resources. Staff are required to be aware of the information-gathering techniques. The principal investigator explores all background sources including the following:

- TRIS abstracts,
- Related reports,
- References and bibliography of reports
- Journals and trade magazines,
- Discussion with researchers, and
- Conferences and seminars on the subject.

Sources of information are limitless. Staff networking and current publications provide the opportunity to explore non-project issues that may have policy implications for the Agency and operational units. The research manager and Agency management can explore these issues further.

B.3 Annotating/Synthesizing References

Following the search for background information (B.2, above), staff members review the material and either annotate or synthesize the results. A synthesis of the relevant background material is prepared by staff for all problems submitted in the solicitation process. Syntheses are retained in the central research files with the submitted problems. Syntheses are valuable for many years and can be used for the following:

- Background information for submitted problems,
- Background information for research,
- Reference for inquiries from operations staff,
- Instructional material for staff, and

- Background for policy issues posed by management.

Annotated bibliographies are completed only at the request of a client. They also are a useful staff instructional technique.

B.4 Complementing/Fostering Implementation Activities

Section 9.0, Implementation Process, details research implementation procedures during which research staff scrutinize the sources listed in B.2, Information Sources, above, for relevant information.

The Project Committee fosters the implementation of the research, but research staff members champion the research by keeping the members informed of the latest data on the subject.

Many of the implementation opportunities for research staff are listed in Section 4.4, Work Program Item Descriptions, and 8.0, Technology Transfer. Research staff maintain an active interest in all research, with the intent of transferring applicable findings to operational units of the agency.

B.5 Availability to Operational Units

To respond to imminent problems, operations staff are expected to take advantage of the expertise and availability of research staff. Often, problems do not require a major research project, only an investigation. Staff can investigate solutions when their work load permits. Written findings are usually submitted to operations staff at the conclusion of the investigation.

B.6 National/International Meetings

Through conferences and seminar attendance, staff keep abreast of developments in their field. Summaries of the meetings are prepared by staff and distributed to appropriate agency staff.

B.7 Develop Seminars and Conferences

Research staff may organize a conference when an issue needs broad participation in expectation of a major program or because of its importance as an emerging issue. At the conference, policy matters are presented by agency management; technical issues are presented by experts in the field. Conference and workshop participation is determined by management. Conference reporting is done by research staff and made available to agency staff. Conferences are held on an as-needed basis.

Research staff also formulate seminars on research recently completed. Meeting agendas and staff participation depends on the level of agency interest. The seminar's invited presenters are experts. Seminar frequency and topics are decided by the research manager.

COMMENTARY:

Technology transfer (T^2) activities are mentioned throughout the guide. Each section stresses a separate point relative to T^2. It can be the most important of the research unit's activities and is found in all aspects of the work.

The information sources for T^2 listed under 6.1.2.B.2 are the most common. Open-ended discussions held by staff and the perusal of current periodicals can also provide pertinent information to the agency.

Some research units may have the time to annotate and synthesize references. Syntheses are time-consuming but can be informative.

They are important for research projects and agency research issues.
The section on the availability of research staff to the operational units stresses networking and the benefits to agency staff.
Attending national meetings expands staff expertise; the development of seminars allows research to influence agency policy. Stressing the long-term benefits of these activities may allow them to be more readily accepted.

6.1.2.C Continuing Project Evaluation

The Project Committee conducts a quarterly review of the project performance relative to the work plan objectives and tasks. In addition to tracking project cost as noted in Section 6.1.2.A.5, above, the committee compares the achievement of milestones with the planned completion of work tasks. A discussion of these comparisons is conducted at the scheduled meetings. Modifications to the research plan are considered when there are deviations from the planned research direction, budget, and/or schedule. The Project Committee suggests project changes with the research manager. The research manager takes appropriate action to enhance the work effort of the project.

COMMENTARY:
The need for review of project activities is implicit in several sections of the manual. Section 10.0, Project Final Evaluation, suggests a formal process using forms, interviews, and economic analyses of the completed research. This section specifies a review of the project performance against the work plan as the project is being conducted.

6.1.3 Product

A description of the daily conduct of in-house activities is provided as a training tool for staff. The principal investigator must understand the importance of frequent contact with staff, client, and committees. Research staff members are given guidance on accumulating and summarizing data, maintaining records, and disseminating topic information. The uses and sources of reference material and technology produced by the research unit are thoroughly described.

6.2 Monitoring Contract Research

6.2.1 Purpose

The ability to contract research is very important to the research unit. Among universities, private consultants, research institutes, and industry, there is a wealth of talent to complement research unit staff. Once a research project is under contract, the research staff must monitor the contract work continuously and meticulously to ensure credible, implementable results.

Development, performance, and completion of research is equally important for staff and contractors. Shifting of project control from the agency to contract research requires formal monitoring methods by the agency.

COMMENTARY:
Almost every state has a contract research program. Some state programs are accomplished entirely by contract—most of these contracts are with universities. The NCHRP Synthesis on "Managing Contract Research Programs" details individual state programs. This section describes the most commonly used research contract procedures in states. Each state must determine procedures that work best under the policy and organizational structure of the state.

6.2.2 Process

6.2.2.A Contract Research Agents

The resources available to the research unit for contract research are numerous. Through the committees outlined in Section 3.3, Research Committees, and the process described in Section 4.2, Project Selection Process, projects in the contract research categories listed in A.1 through A.5 below are approved.

COMMENTARY:
Agency criteria used to select research contract agents are not specified in the guide. Often, selection is based on policy, staff availability, staff expertise, or complexity of research. Reference to these factors is given in the guide; the state can be more explicit and include a discussion of them either here or in Section 5.3.2.A, Selecting a Contract Program.
Only those agents used by the state should be listed; several states do not use private consultants for transportation research. A.5, Other Special Arrangements, is left open to accommodate unique situations.

A.1 University

Agency contracts with universities are governed by basic agreements. All university-contracted projects have an Agency sponsor who serves on the Project Committee monitoring the research. Universities may have an advantage over other research agents by having many graduate students available at greatly reduced labor costs.

University academics are often sought on a select basis; an RFP is issued to a university with the expectation that only one proposal will be returned to the Agency.

A.2 University Transportation Center (UTC)

Section 4.4.5, University Center Research Program, gives background information on this program. Annually, the Agency attempts to set aside state funds to match federal UTC funds.

Projects contracted through this program have a sponsor within the Agency who serves as the project monitor on the Project Committee. In the absence of a Project Committee, the monitor performs the functions of the committee, as described in Section 3.3.2.C. The research unit administers the contract and project proposal.

A.3 Private Consultant/Research Institute

Projects that are not contracted with universities are advertised as noted in Section 5.3.2.B, Solicitation of Contractor. There are times when a sole-source award to a private contractor is appropriate, depending on the complexity of the research.

A.4 Pooled Fund

National and regional pooled fund projects are described in Section 4.4.3. The research unit administers the State's participation in these programs. If project panel membership cannot be obtained from the operating units, a representative from the research unit is selected. Monitoring methods are different from other contract research efforts and are defined in Section 4.4.3.

A.5 Other Special Arrangements

The research project may require special contractual arrangements such as collaborating with other State agencies; working with an open-ended contract; or forming a consortium of government, academia and private industry. Perceived complexity and expertise required for the project determines the need for special contractual arrangements.

6.2.2.B Monitoring Methods

A Project Committee monitors the UTC, university, private consultant/research institute and other special arrangement contracts. The Project Committee functions are described in 3.3.2.C; pooled fund contracts are described in 4.4.3.

The Project Committee encourages a high level of communication with the contractor, good quality of technical work, and adherence to contract milestones. Technical progress and adherence to the scope of work of the research are the focus of the Committee. Technical progress includes achieving milestones and implementation potential.

Research unit staff on the committees support administrative needs, champion the research, and strive to maintain its focus.

COMMENTARY:
Some states use methods of monitoring the research other than those mentioned, namely, only research staff (to the exclusion of operations staff) or only operations staff (to the exclusion of research staff). The guide should reflect this throughout and not just in this section.

6.2.2.C Tracking Contract Progress

Project Committee meetings with the contractor are important. Other meetings may involve research partners or Agency management. Meetings maintain the necessary high level of communication, and their frequency is set by the contract.

Reports, defined in Section 7.1.2.D, are reviewed by Committee members who provide the contractor with feedback on all aspects of the contract, including the scope, technical progress, reporting, maintenance of necessary levels of staff, and implementation potential.

All invoices submitted by the contractor must be accompanied by a concise statement of activities. Time and budget information are included on the Project Task Completion Schedule (Form 6-1 in the appendix), which is submitted with the invoice by the contractor. Research staff are responsible for tracking the contractor's adherence to the budget and schedule on the project. The research representative analyzes these items, judges the percent complete against the amount billed, and relays the results to the Project Committee. The Committee recommends action to the research unit in case of overruns in either time or budget. In response, the research unit may issue the following:

- Verbal instructions,
- Written instructions, or
- A deferral of contractor payment.

6.2.2.D Implementation Efforts With Contractor

The contractor is generally asked to provide the agency with some form of technology transfer method, such as training courses or seminars, in addition to the reports on the research (see Section 4.4.8, Technology Transfer). Careful thought should be given to the anticipated techniques of transferring technology for each project before including technology transfer in the contract.

6.2.2.E Contractor Reports

The contractor must submit reports as defined in the contract. Reports contain the information described in Section 7.1, Project Level Reporting, and can vary with each contract.

6.2.2.F Continuing Contract Evaluation

The Project Committee may judge that the contractor's performance is less than acceptable. A series of progressive steps are used to remedy the situation, such as the following:

- Verbal notice of specific areas of unacceptable progress,
- Written notice of the conditions under which the contract would be terminated, and
- Withholding payment until progress satisfies the Committee.

If progress remains unacceptable, the next step is to notify the contractor formally that the contract will be terminated on a specific date, in accord with the terms of the contract. Steps taken to close out the contract include appropriate disposition of equipment and property purchased under the contract, a status report on the work, a final audit, and a final payment.

6.2.2.G Contract Closeout

Once the Project Committee accepts the contractor's fulfillment of the terms of the contract and the final report has been approved, the research unit will resolve the following items prior to formally closing out the contract:

- Printing (or acceptance) of the final report,
- Appropriate disposition of equipment and property,

- Final audit, and
- Final payment.

6.2.3 Product

One of the most important and sensitive functions of the research staff is the delivery of contract products. Contract research monitoring requires a diligence that is more demanding than that required for the conduct of in-house research. The physical remoteness and relative independence of the contractor compels the agency to take steps to address these factors. This section details some of the steps that can be taken to monitor contract work.

SECTION 7.0 PROGRAM REPORTING

7.1 Project Level Reporting

7.1.1 Purpose

Research efforts focus on customer benefit and implementation. Implementation is aided by an exchange of information that begins with clear, concise, and complete project reports. Progress and accomplishments are detailed in reports showing benefit to the customer.

> *COMMENTARY:*
> *Section 11.1, Overall Program Performance, describes implementation results, milestones, funding, and scheduling of all work program projects. This section, aimed at the individual project and the reporting of the status of the project, provides more detail than in Section 11.1.*

7.1.2 Process

Reporting of project details is defined in subsections 7.1.2.A through 7.1.2.C. Form 7-1 in the appendix details a quarterly progress report. Contents of the interim and final reports are discussed in D.2 and D.3 below.

> *COMMENTARY:*
> *Reporting the project status, technical, and financial information, presented in A., B. and C. below, keeps the client and the Project Committee informed. Reports also allow the research manager's representative to track progress against expenses. It may be unrealistic for very small or short-term projects to report this level of detail. There may also be a lag between the time the reports are issued and when the financial information is available on state-supported projects. To accommodate the lag, the reports can either be delayed until the financial data are available or the financial data can be entered in the following cycle's report. Small or short-term projects may not require detailed information for reports. These projects can be defined by level of staff effort, total cost, or some other measure.*
> *It may be desirable to assemble the project status and technical findings as a combined discussion for each task. The difficulty with this approach is that the burden is put on the reader wanting project progress rather than task progress.*

7.1.2.A Project Status

A.1 Tasks

Each major task outlined in the work plan is described briefly, whether completed or still in progress.

A.2 Schedules

The planned and actual schedules for each task are shown. The percentage completion is shown using Form 6-1 in the appendix.

A.3 Problems/Resolutions

Financial, staff, equipment, and technical problems are discussed in relation to individual tasks. Resolution or attempts at resolution are also noted.

7.1.2.B Technical Findings

B.1 Milestones

Each task has a milestone—either a summary report, a design of an installation, an installation completion, data collection completion, or a specification. A brief description of steps to reach milestones for each task is given.

B.2 Accomplishments/Implementation Efforts

Each milestone describes the completion of a task. Each task may result in an accomplishment. Accomplishment is defined as advancement of an implementable product. This is the most significant section of the report. The success of the research and implementation of the results have the most importance for the customer.

7.1.2.C Financial Status

C.1 Budget

Budgeted line items for salaries, overhead, travel, equipment, and miscellaneous fund categories are shown.

C.2 Expenditures

Line fund expenditures are shown for salaries, overhead, travel, equipment, and miscellaneous funding categories. The same line items are listed for contracts. The budget and expenditures are shown in the same table.

7.1.2.D Reports

D.1 Quarterly

Project status reports are submitted quarterly, incorporating the information in 7.1.2.A. through 7.1.2.C, using Form 7-1, in the appendix, as the format. Contractors provide identical information in their reports, but may use their own format. The Project Task Completion Schedule (Form 6-2) must accompany the quarterly report. The report is distributed to the Project Committee and affected units of the Agency.

D.2 Interim

Projects that are expected to take more than 2 years to complete or are expected to have a significant accomplishment during the course of the research are detailed in an interim report. The interim report uses the same format and includes the same material as that in 7.1.2. D.3, Final. Each section of the report indicates the relative completeness of the research. This report covers a significant part of the research, including impediments to implementation and

suggestions for overcoming the impediments. The interim report is distributed to members of the Project Committee and select operations units.

D.3 Final

The Project Committee members associated with the project are aware of the findings prior to the final report. However, the research community and operational units affected by the work must be informed. The final report is the most lasting and complete document of the research and is carefully assembled to include at least the following information:

- Summary—a brief description of the work and conclusions;
- Recommendations—findings, conclusions, and suggestions for additional research;
- Implementation Plan—the procedure to introduce the results into practice, including suggestions for organizational responsibility;
- Introduction—discussion of the problem, its background, and a concise history of research;
- Work Plan—experimental research plan, data collection, description of sites and activities, and an analysis of the data; and
- Findings and Conclusions.

The final report receives the widest possible distribution. It is forwarded to the Project Committee, affected operations units, potentially affected customers outside the Agency, other state research units, TRIS, and other national databanks.

COMMENTARY:
Every project generates reports. Their type and frequency will vary with the research project, the expectations of the customer, funding source requirements, and other factors. The format for reports using federal funds should be consistent with FHWA guidelines. The agency may want to include or refer to their own reporting procedures in this subsection. The reports listed are used most commonly.
The cyclical report can be generated on a quarterly, semiannual or annual basis. The text assumes they are quarterly.
The Project Committee (Section 3.3.2.C) members are the principal reviewers of the reports. Their meetings will include a review of the findings in these reports.

7.1.3 Product

Most professionals in the Agency and those interested in the research use the project reports for information. Project reports are the official documentation of the research. Quarterly reports are used to monitor progress. Interim and final reports form the basis for discussion and presentations to the transportation community. This section provides the technical and financial status of a project in cyclical and final report form that forms the basis for the implementation effort. Information for the different reports has been offered.

7.2 Program Level Reporting

7.2.1 Purpose

The purpose of research is to obtain the results of the individual projects. The success of the research unit depends on program results. The program report describes the research activities performed by the research unit. This report tends to receive the most attention from administrators and managerial reviewers. Because management usually reviews the whole program (not individual projects), reports should be succinct. Research effectiveness is measured by its achievements and by the interaction of research staff with the Agency's operating units. All research unit activities are included in program level reports.

7.2.2 Process

This section summarizes the status of the projects and staff technology transfer activities. Section 11.1, Overall Program Performance, outlines the items of significance that are incorporated in the reports of this section. The importance of the items, forms for reporting on them, and the frequency of reporting are addressed. Examples of the formats (Forms 7-2A, 7-2B, and 7-2C) are provided in the appendix.

> *COMMENTARY:*
> *Several suggestions for inclusions on the program level are made in this section. Many may have no significance for a particular research unit. Although all suggestions are not pertinent, aspects of each of the areas listed should be considered for program level reporting. It is important that comments are made about all of the research unit's activities. The range of unit functions must be brought to the attention of other agency units. The importance, description, and reporting of research functions must impress those who receive the report.*
> *The section separates the highlights from the problems, but they can be combined effectively. Different reporting methods offer various ways of getting the message out. All of the reporting methods can be accomplished concurrently.*
> *Section 7.2.2.A, Program Highlights, Section 7.2.2.B, Program Problems/Issues, and Section 7.2.2.C, Budget/Expenditures, combine the activities of the individual projects, producing summary results for the entire work program. Section 11.1, Overall Program Performance, lists the results of the individual projects. All of the following sections and 11.1 should be combined using the techniques listed in 7.2.2.D, Reporting Methods.*

7.2.2.A Program Highlights

Information listed in this subsection reflects the positive results of the research program. The information describes activities that the research unit is involved with and summarizes the various accomplishments. Customers are expected to seek more information on each item. The information is summarized in Form 7-2A in the appendix.

A.1 Projects

Program level reviews of projects provide information on the various organizational functions engaged in by the research unit. Details of projects are contained in the project scope of work; project status is detailed in the quarterly reports described in Section 7.1, Project Level Reporting. Program level reporting gives the number of projects and source of research organization (staff, contract, etc.) in the following categories:

- Final reports,
- Projects underway, and
- Functional area of research.

A.2 Implementation Efforts

The significance of reporting implementation successes is reflected in the importance given by the operational units to achieving practical, usable results from the research. Positive actions resulting from the discussions listed in Section 11.1.2.A, Implementation Results, are reported. There is no time limit for the reporting of implementation successes. Projects may be completed years before implementation is completely achieved.

A.3 Funding

Management should have a program level knowledge of research expenditures. The reporting of annual programmed and year-to-date expended funds is shown by source of funds (e.g., SPR, state, and so forth) and by researcher (e.g., staff, university, private consultant, or other).

A.4 Milestones

All research unit tasks are reflected in a list of the milestones achieved. These are discussed in Section 11.1.2.B, Milestones. This is the most encompassing description of accomplishments for the research unit. The milestone list reflects the range of research operations and accomplishments achieved during the fiscal year.

A.5 Staffing/Facilities

Management should be kept informed of current levels of research staff and support in terms of facilities and equipment and fiscal year changes in the level of this support. The positive effect of the research unit on the Agency's operations is measured by the implementation efforts and by the staff and support facilities put at the disposal of the Agency's operations staff.

A.6 Conferences/Meetings

One of the most effective methods of disseminating information is through open meetings and conferences. The research unit organizes and conducts conferences on all issues that have the potential for solution through technology. Project meetings are held with the frequency noted in the project scope of work or stated in the contract. The conferences arranged and attended and the project meetings held are listed.

7.2.2.B Program Problems/Issues

Problems encountered during the research program are catalogued in this section. This gives management the opportunity to detect possible trends and determine potential solutions that could enhance the entire research program. Distribution of this information is limited to Agency management and select operations staff.

B.1 Projects

Problems experienced with projects may include staff, data, equipment, and site availability. Situations in which office staff reassignments affect several projects should be shown in B.4, Staffing/Facilities/Equipment. The term of a project dictates the length of time that these problems are listed in the report.

B.2 Implementation Efforts

Because difficulties with implementation efforts may be unique to the project and technology transfer, they should be categorized separately. Listing these problems separately may make it easier for the affected operations staff to address them.

Sometimes implementation efforts extend over many years; if there are problems with these efforts, they will appear in the report each year. For these cases, the Research Management Committee determines when the implementation effort should be terminated.

B.3 Funding

Funding problems affecting staff and contract research are listed. Often, contract problems involve administrative issues. Frequently, staff experience difficulties in finding research funding sources outside the State and SPR categories. Equipment purchases may also be problematic. Financial problems may be long standing and transcend the current fiscal year.

B.4 Staffing/Facilities/Equipment

Resource shortages and maintenance problems are usual issues under this category. Needs are based on the projected plans for the unit. Some of these issues are easier to solve than others. It is necessary for management to be apprised of concerns in these areas on a regular basis. This listing is not constrained by a fiscal year, but reflects the research unit's needs at the time of the report.

7.2.2.C Budget/Expenditures

Financial information on research is provided on a monthly basis by the accounting unit of the Agency. The information is summarized by the research unit in three tables as follows:

- For each source, the appropriated, programmed, and expended funds;
- For the total budget, each budgeted item showing the appropriated and expended funds; and
- For the contract research program, each budgeted item showing the total programmed for all contracts and the total expended for the item.

The first two tables reflect fiscal year data; the third reflects data for the contracts that are currently active. The information is summarized in Form 7-2C in the appendix.

Agency management has a responsibility to ensure that their units are properly funded and are expending those funds at an appropriate rate. Exhibiting the financial information this way will allow management to scan the data and judge the monetary flow versus the problems listed in B.3, Funding, above.

7.2.2.D Reporting Methods

Program level reporting is described below. Various methods of dissemination are described; the research unit will use the most appropriate method.

D.1 Formal Report

The formal report is issued on a cyclical basis, usually annually. Organization and research unit data and charts describe the research operation. In addition to select material from 7.2, Program Level Reporting, above, there are brief descriptions of active projects. More descriptive information is presented for some of the significant implementation successes. All research customers receive reports and are asked to respond with comments and inquiries. Their comments enhance future reports.

D.2 Letter Report

The letter report is usually reserved for select projects or transmittal of program level information or highlights on select projects. Program level information is distributed annually. Recipients are the members of the Advisory and Research Management committees. The letter report annotates the data transmitted in tabular form, including the program highlights, problems/issues, and the budget/expenditures detailed in Sections 7.2.2.A, B and C, above. Annotation of the data informs the readers without them having to scan the tabulations.

D.3 Newsletter

The research unit publishes a semiannual newsletter containing information on current research projects of the research unit and highlighting the implementable products. The newsletter is organized and written by select staff of the unit. It is distributed to the management of the Agency's operations units, all transportation agencies within the state, and the research manager of all state transportation agencies in the country.

COMMENTARY:
Content, format, and style of newsletters vary. The research unit and Agency management should give thought to these items, because they probably will remain constant for many years.

D.4 Meetings With Management

Meetings are the most effective means of reporting program progress. Senior staff of the Agency can inquire into program progress and receive input from other members of management. These meetings are arranged by the research unit at the request of management.

7.2.3 Product

Project and program reporting fulfill the formal requirement of the research unit to ensure that research results are disseminated and offer evidence that progress is being achieved. On a project level, the final report on the research eventually can satisfy the users, but status reports are important to maintain a focused research effort. Because management is the primary user of program level reporting, such reporting should reflect what management wants and needs.

SECTION 8.0 TECHNOLOGY TRANSFER

8.1 Overview of Activities

8.1.1 Purpose

Research is described as the careful, systematic study to establish facts in a specific field, but the crux of the effort for the state is the application of research results. Technology transfer goes beyond the use of the results of the research projects conducted by the unit. T^2 is defined as the search for information on a subject, the assimilation of the information, an evaluation of its utility to the subject, and the incorporation of the relevant aspects into an implementation effort or into the design of a research project to further the knowledge on the subject. Research staff have acquired an expertise in a range of transportation fields. That expertise is continuously in demand by the operating units of the Agency. Further, the transportation field is dynamic, a fact that compels the research staff to keep the state transportation community informed of the latest developments.

> *COMMENTARY:*
> *T^2 is one of the most time-consuming activities of the research unit. It is discussed in three section of this guide. Section 4.4 defines, in general terms, the funded activities that are included in the T^2 line item of the research work program. Section 6.1.2.B specifically describes the T^2 activities conducted by the research staff during the course of their work. This section gives detail for support and outreach activities included in T^2 efforts.*

8.1.2 Process

8.1.2.A Customers

Everyone benefits from the transportation system and from system-related research. In Section 1.2, Purpose, the immediate beneficiaries of research were stated to be the Agency, its employees, and other transportation agencies and users. Technology transfer activities of research are directed to the immediate customer with the larger community in mind.

8.1.2.B Partners

Research Partners, defined in Section 2.4.2.A, also are the beneficiaries of research. Gaining the support of the beneficiaries of research was outlined in Section 2.4, Developing Customer Support. Partnerships formed with Agency operating units, universities, companies, transit authorities, consultants, contractors, local governments, regional agencies, FHWA, and the public require constant renewing. Transfer of technology cannot be accomplished without these partners.

8.1.2.C Technology Transfer Activities

The main goal of conducting applied research is to improve or enhance transportation practice. In order for research results to be used, a transfer of knowledge from researcher or other transportation professional experienced in the use of a technology must be made to the new/potential user. Technology transfer activities are broadly defined. The type and level of activity depend on the technology itself. In addition, the processes, methods, and products involved in the agency's technology transfer activities are so diverse that several mechanisms are used to promote the most effective transfer process.

Technology transfer occurs within and outside the agency. Most frequently, the agency culls applicable innovations from research results performed with agency research funds. The process encompasses the dissemination of applicable research results and knowledge regarding new processes, methods, and products within the agency and the transportation community as a whole.

Technology transfer activities also involve technology scanning—selecting applicable innovations from research results or other new processes, methods, and products available outside the agency. These innovations come from within the transportation community or a related technical field, such as defense technology. Many external sources for innovations are available. The broad reach of the agency assists in attracting the best and most appropriate technologies for application to its practice. The agency's technology transfer activities include use of innovations and sharing the most beneficial with others.

The agency conducts or participates in a variety of activities under the technology transfer umbrella. Routine dissemination of research reports and other actions inform transportation peers of the agency's successful research results. Other technology transfer activities are performed as required. Demonstrations and workshops, information brochures, and other special media, as well as technical assistance and implementation-friendly packaging are some of the activities most often used.

COMMENTARY:

This section gives an overview of the technology transfer activities most likely to be used within an agency. Most agencies perform technology transfer activities through dissemination of the results of their research efforts. Not all agencies scan or actively solicit technologies from external sources such as defense technologies or international applications. If scanning is not done within the agency, the research unit may eliminate the second paragraph of this introductory section as well as Section 8.4 on technology scanning. One of the most prominent external sources of technology for transfer into the agency is FHWA. All agencies benefit from FHWA's technology transfer efforts. The research unit's manual should incorporate those efforts into the discussion. See also Section 4.4.8 Work Program Item Descriptions—Technology Transfer.

8.1.3 Product

A knowledge of the customers, partners, and activities involved with the T^2 activities are important to the research unit. T^2 is an activity that is conducted on a daily basis. All methods of collecting and disseminating information on transportation improvements are pursued to foster implementation and to avail research unit partners of staff expertise and keep the transportation community apprised of the latest advances in the field.

8.2 Benefits of Technology Transfer

Technology transfer benefits to the Agency are numerous, but the most significant advantage is that the Agency's transportation problems are solved in a more cost-effective and timely manner. Technology transfer promotes innovation within the agency and eases the adoption of innovations within the transportation community at large.

Technology transfer provides substantive technical information by providing technologies shown by others to be appropriate for the agency. In such cases, scarce funds are not wasted on duplicative research and development. Instead, they are spent efficiently on field-tested processes, methods, or products. Technology transfer resulting from FHWA, state, and collaborative relationships with the AASHTO member departments is reviewed for relevance to the Agency. Sound practices and innovative technologies are shared with county- and municipal-level agencies within the state. The transfer of effective processes, methods, and products increases the technical quality and ability of the whole state to better provide transportation services to its citizens.

Technology transfer also brings state-of-the-art innovations necessary to sustain quality service for the public into the Agency. Only through contact with other transportation professionals, researchers, manufacturers, and organizations does the agency learn about appropriate innovations to better meet its mission and objectives.

> *COMMENTARY:*
> *This section may be augmented with specific examples of benefits from past technology transfer efforts. Most important, technology transfer should be an integral part of an agency's mission of providing safe, reliable, cost-effective service to its customers, the public. Technology transfer has a dual nature. It is sharing what the agency knows to be effective and learning from others' experiences. Benefits of technology transfer are difficult to quantify, yet in most cases, the process of passing along valuable information regarding solutions to transportation problems saves time, money, and staff resources.*

8.3 Information Resources

Many information resources are available to foster technology transfer within the agency. The most commonly used resources are publications and other media from FHWA, TRB, and

AASHTO, and colleagues within these organizations. Manufacturers, vendors, and the research community also offer a great deal of information regarding innovative processes, methods, and products. Because international transportation information is easily obtainable, technology transfer is global in scope.

COMMENTARY:
If there are specific resources used for technology transfer efforts, they may be listed here and then explained in greater detail below in a separate section under this general topic.

8.3.1 Library or Reference Center

Some of the most active technology transfer activities are conducted by the Agency library. Library resources are available to all Agency employees and to researchers and others contracted by the Agency. The library offers walk-in lending services and electronic search capabilities for many national databases.

Most important, the library's primary effort is to transfer technical information to Agency employees, including the following:

- Report distribution,
- Monthly book list: monthly list of additions to the library,
- Publications catalog: general publications list,
- Monthly library displays: special technical displays highlighting new research in specific topical areas,
- AASHTO RAC Research-in-Progress database input,
- TRIS searches and maintenance of agency submissions to the database, and
- Other electronic databases.

COMMENTARY:
Many agencies have on-site libraries that offer numerous technology transfer functions. This section is representative of how transportation agency libraries assist in the technology transfer efforts of the agency.
NOTE: See the discussion in the following section on TRIS—therein the research unit is considered ultimately responsible for conducting such searches. The appropriate staff organization responsible for searches/scans should be clearly defined in this and the following section.

8.3.2 TRIS

As described in Section 4.4.8.A.2, TRIS is a primary technology transfer source for the agency. The database contains over 400,000 records describing transportation technologies and innovative processes and methods. The database is accessible by direct request to the TRB

personnel responsible for TRIS, through direct modem, and through the AASHTO VAN computer network.

TRIS is a source for information retrieval and information dissemination. The research unit searches the database for the agency. In addition, the research unit also submits data regarding agency research efforts to TRIS.

The tasks for which TRIS is most frequently used are as follows:

- Literature scans and searches to determine state of the art,
- General scans and searches for technical reference supporting agency operations, and
- Dissemination of information about the agency's research projects (in-progress status and project results).

COMMENTARY:
The method to access TRIS and the person responsible can be detailed in this section. Other general uses of TRIS can be added as bullet points to the above list.
NOTE: this section states that TRIS searches are the responsibility of the research unit—in fact the library staff or others may perform the search functions. The appropriate staff organization responsible for searches and scans should be clearly defined.

8.3.3 Other Resources

There are many other resources that the research unit uses for technology transfer, including face-to-face or some other personal contact with professional colleagues, technical literature, as well as other technical materials and sources.

Several technology transfer activities in which the research unit may participate include the following:

- AASHTO committees and subcommittees, including the Research Advisory Committee, the National Transportation Product Evaluation Program (NTPEP), SHRP implementation committees, and NCHRP panels;
- TRB technical committees and the TRB annual meetings;
- American Society for Testing and Materials technical committees;
- National Institute of Standards and Technology activities;
- Highway Innovative Technical Evaluation Center technical committees;
- Industry associations and professional societies;
- FHWA regional and national technical panels and committees;
- Electronic access to literature via computer (Internet's World Wide Web); and
- Technical publications (e.g., journals, periodicals, and other literature).

All organizations listed above also provide literature, research results, or other materials to assist in the technology transfer process.

COMMENTARY:
Specific avenues for technology transfer may be listed in this section, but the primary purpose is to show the broad reach of the research unit for its technology transfer efforts.

8.4 Marketing Techniques

The research unit makes every effort to promote effective use of the results of its research efforts by the Agency and others. In addition, the unit is committed to encouraging the consideration of promising technologies used by others and applicable to agency operations.

The research unit understands that users of innovations (research results or other applicable new technologies) are research program customers. The research unit uses various marketing strategies regularly to foster technology transfer as follows:

- Product assessments—critique of technologies for potential Agency use;
- Market/user assessments—determination of operational areas that could best profit from early adoption of new technology, priorities for continuing the adoption by users, and fostering of champions within the Agency user units;
- Enhanced communications—focused packaging of research results tailored to the users' needs; continued communications with users to determine problems;
- Resources analysis—staff, facilities, and funding required to transfer the technology; and
- Barriers and boosters analysis—identification of technology barriers so as to capitalize on situations that ease the transfer of the technology.

COMMENTARY:
The level of sophistication/effort for marketing technology within the agency varies with each organization. Details of the research unit's marketing activities on technology transfer may be included as subsections of this section. The research unit should view their operations as services to customers who can choose to buy or reject these services.

8.5 Demonstrations

When appropriate, the research unit sponsors and promotes demonstrations, showcases exhibits, and other field or operational presentations of technologies that could benefit the Agency. In general, demonstration technologies originate with FHWA, AASHTO, and industry.

Once the research unit determines that an organization is willing to perform a field demonstration of new technology, it solicits interest from within the agency. The research unit may coordinate the demonstration or assist the applicable agency technical unit. The new technology is introduced to as many agency personnel as possible. Government officials, academia, researchers, consultants, and contractors often are invited to attend, when appropriate.

COMMENTARY:
If the research unit has scheduled regular technology demonstrations, the details may be included in this section.

8.6 Technical Assistance

Research unit staff provide consulting services on an as-needed basis to other operational units within the agency. Requests for such services are made through the research unit manager. The services provided are of relatively short duration and generally involve problems requiring an immediate solution. The research unit places a high priority on these requests and is committed to providing quality responses as soon as possible. A brief letter report of findings and or recommendations is provided to the operating group.

COMMENTARY:
In research organizations where highly trained technical staff perform research, technical assistance to other operational units is often expected; the research units that provide emergency consulting to other units within the Agency have greater credibility. If the research unit provides technical assistance, this section should mention the technical expertise that is available. If outside technical assistance is timely, procedures, duration, funding, and other delimiting factors should be noted. Some states have a line item in the SPR work program to fund technical assistance efforts. Other states require the operating agency to fund the effort.

8.7 Local Technical Assistance Program (LTAP)

This FHWA program was established to encourage cost-effective improvements to roads and bridges owned and maintained by local governments. Federal aid is available for 50 percent of the program funding. The State and the University of [*fill in university name*] match the funds.

Through technology transfer, training courses, users' manuals, on-site demonstrations, and a strong network of technical expertise available to the local governments, the program has successfully furthered implementation of highway innovations at the local level.

COMMENTARY:
FHWA began LTAP in 1981 (then called the Rural Technical Assistance Program) and now funds technology transfer centers in each state, Puerto Rico, and four centers for Native American tribal governments. Local governments (including urban areas of up to 1 million in population) are eligible for LTAP services.
Details of the agency's LTAP activities should follow the introductory paragraph above and include the following:

- *Organization or university administering the program,*
- *Funding amounts and sources of matching funds,*
- *Length of time in operation,*
- *Staffing,*
- *General services provided/technical activities,*
- *Detailed "customer" list, and*
- *Program benefits.*

8.8 Technology Scanning

The Agency must know about the most recent technological developments in transportation. Research unit staff are committed to scanning information in the various transportation and related technical fields to determine the applicability of innovations. Active efforts are made to be informed about domestic and international transportation technical advancements.

Literature is scanned for promising technologies. The research unit requests materials about various technologies and disseminates them to applicable Agency staff. If there is sufficient interest in the technology, the research unit will organize a presentation or an informal forum with individuals knowledgeable about the technology or will use some other method to inform Agency staff about the technology. The research unit will contact professional colleagues having experience with the technology to further determine practicality for the agency and to determine if field (or in-place) observation of the technology can be made by Agency staff.

As a result of technology scanning, the research unit staff also will take the appropriate actions to test, further research or develop, or encourage application of new technologies selected by the Agency's Research Advisory Committee.

COMMENTARY:
The most vital function of technology scanning is to provide agency staff with an additional opportunity to keep up-to-date on promising technologies.
The research unit specifies their technology scanning activities including individuals responsible for the activity (librarian, individual researchers or a technology transfer specialist), method of distribution of the "scanner's" findings, general resources scanned, mechanism used to incorporate the findings of others, and procedures for appropriate review by agency staff.

SECTION 9.0 IMPLEMENTATION PROCESS

9.1.1 Purpose

The research unit strives to implement the results of its research projects. Planning for implementation starts as early as the problem statements, which are assessed for implementation potential.

As projects near completion or are close to producing results, the research unit evaluates them for applicability to Agency practice. In conjunction with potential users and the Project Committee, the research unit prepares an implementation plan to ensure effective and timely application of the research results throughout the Agency. Implementation activities, methods, and actions required by the numerous technologies with which the Agency deals are broad and flexible.

Funding for implementation activities comes from the research unit's SPR program. A budget line item is included in the SPR work program for implementation of research, when a large-scale effort is anticipated. This line item reserves funds for the testing, adaptation, packaging, and promotion of new technology from the Agency's research unit activities and any other source. If other implementation resources are required (e.g. facilities, staff, or other items), they are detailed. Commitments for these are obtained prior to application of the technology.

Implementation monitoring and evaluation are performed by the research unit and the Agency operational unit. Reports of progress are made to the appropriate committees overseeing the Agency's technical and research efforts.

> *COMMENTARY:*
> *The research unit should exert every effort to ensure the timely implementation of research results. Although the unit staff may not actually perform the implementation tasks, implementation of research results is the most tangible means of measuring the effectiveness of the research unit's performance; therefore, personal involvement and superior efforts should be made to make the implementation effective and timely.*

9.1.2 Process

9.1.2.A Implementation Plan

The research unit prepares an implementation plan for all research projects producing results suitable for application as follows:

- Project title;
- Project Committee members and project manager's name;
- Description of expected results;
- Anticipated applications or potential use;
- Implementation user group and a principal contact;
- Product champion(s);
- Benefits from the implementation;

- Implementation cost in labor, facilities, other resources, or direct costs;
- Funding source;
- Implementation risks;
- Anticipated barriers and strategies to overcome them;
- Description of each step of the process and the individuals responsible;
- Technology transfer methods to be used, such as
    - Literature dissemination,
    - Training requirements,
    - Demonstrations and pilot projects,
    - Conferences and other presentations,
    - Library display,
    - Entry of results into agency and national databases, and
    - Other technology transfer activities;
- Time frame and milestones to measure progress; and
- Evaluation time frame and reporting requirements (see Section 9.1.2.B).

The implementation plan is approved by the Project Committee. In addition, the Research Advisory Committee reviews and comments on the plan and submits its recommendations to the Project Committee.

> *COMMENTARY:*
> *The research unit may or may not elect to produce a formal implementation plan for each new technology or research result. Research shows, however, that planning for implementation of research results is critical and increases the potential for successful application to practice.*
> *Alternatively, the research unit may incorporate an implementation plan within the scope of work for the research. The researcher, in conjunction with the research unit project manager and the potential users, produces an action plan for implementation.*

9.1.2.B Monitoring Implementation Activities

All research projects are monitored (see Section 6.0, Conducting and Monitoring Research Projects) to ensure appropriate research performance as well as to maintain adherence to appropriate research methods. In addition, research projects also are monitored to determine the appropriateness of the implementation planning. Significant mid-project changes may alter ultimate implementation actions. If change occurs, preliminary implementation planning is updated accordingly.

Implementation activities are tracked by the user and the Project Committee. Monitoring includes reviewing the description of steps given in the implementation plan. Brief letter reports of progress are prepared by the research unit for the Project Committee and the Research Advisory Committee. Both committees are given an opportunity to comment and to make recommendations on the implementation progress.

The implementation process is evaluated according to the details of the implementation plan. Evaluation occurs after an appropriate period of time so that the effectiveness of the implementation can be measured. The time frame and milestones for evaluation are included in the implementation documentation. Questions considered include the following:

- Is the process, method, or product performing as anticipated? If yes, how? If not, why?
- Are user needs being met as anticipated? If yes, how? If not, why?
- Is the innovation being implemented throughout the agency? If not, why? (Which significant barriers were overcome and which must be addressed?)
- Have benefits and objectives been achieved or is there an indication that they will be met? If yes, what benefits exist and to what extent?
- Are costs of implementation as anticipated? If not, why?
- Has the anticipated implementation schedule been met? If not, why?
- What improvements to the innovation should be made, if any?
- What additional actions to broaden the implementation of the innovation will be taken?

COMMENTARY:

The research unit should specify the level of detail it will use in evaluating the effectiveness of the implementation process. In addition, a format for the evaluation report and a general schedule of activities should be outlined. Other items to include in this section are the disposition of the evaluation report and the actions taken as a result of its review by the appropriate decision makers. The evaluation process is part of quality performance; it is an opportunity for continuous improvement.

Data from project evaluations (Section 10.0) may provide useful information for this activity.

9.1.2.C Facilitating Implementation of Research Results

Many activities assist the implementation of research results. Each research project is unique and demands a customized strategy to implement its results. The research unit uses appropriate strategies for each implementation effort. Practices listed below have high potential for boosting implementation effectiveness. These are the practices used most often by the research unit to increase the effectiveness of the implementation effort:

- Real-user settings when performing pilot or demonstration projects;
- Ensures that the innovation is matched to the users' needs;
- Strong commitment from senior management for implementation of the innovation;
- Adequate funding to support the innovation;
- High degree of collaboration among users, researchers, and industry;
- User participation at vital stages of the research and development efforts;
- Innovation champions on site while implementation is being performed;

- High level of relevant technical skills by users who are properly prepared to deal with the innovation;
- Implementation package accompanies the innovation and continued technical support is available to the users during implementation;
- Clear goals identified for the implementation effort; and
- Funding specified for implementation efforts.

COMMENTARY:
All of these items may not be appropriate for implementation of innovations resulting from the research unit's efforts. The list shows what could be done for any given innovation. Other practices used by the research unit should be incorporated into this section. Note the items given in the above list are derived from recent research and should continue to be so identified if other items are added.

9.1.3 Product

Implementation may be the most rewarding part of the research process. This section outlines those steps which would put the research results into practice. The implementation plan is the framework for everyone's involvement. Monitoring ensures that the research is geared toward implementation. Finally, implementation activities demonstrate the benefits of the research unit to the Agency.

SECTION 10.0 PROJECT FINAL EVALUATION

10.1.1 Purpose

Projects are evaluated throughout the course of the research effort, as described in Section 6.0. In addition, after the research is completed and project deliverables are implemented, a final project evaluation is performed.

Final evaluations are performed to assess the value of the research to the Agency, to learn what was done well, and to determine improvements for future research efforts.

Evaluations can provide benefits to the agency that may result in 1) cost savings, 2) improved processes or methods, 3) safety improvements, and 4) improved or increased information for management decision making and policy formulation. Cost savings and safety improvements can be quantified. Improved methods or information can be documented by qualitative means.

> *COMMENTARY:*
> *It is important to clarify any misconceptions regarding the types of evaluation that should be performed on research projects. Section 10 shows that the final evaluation is conducted after the major experimental portion of the research project is complete, during implementation of the research results. Section 6.0, Conducting and Monitoring Research Projects, covers the ongoing project evaluation process.*
> *Evaluation is the last major procedure performed by the research unit staff. They continue involvement in technology transfer and implementation activities, as necessary. The project final evaluation process can vary in its details, depending on agency policy, time available, and the level of expertise of the staff. Keep the evaluation goals clear in order to assess value and to find ways to improve the research process. Have appropriate staff resources to conduct the evaluation. Furthermore, research unit staff must be trained to deal with the complex methodologies that may be required by the agency.*

10.1.2 Process

10.1.2.A Process Internal to Agency

The research unit performs final project evaluations. Depending on the complexity of the project, each project is reviewed and research performance and research results are analyzed.

Final evaluations are made approximately 6 months to 1 year after the major experimental portion of the research effort is completed. Implementation must be progressing, but may not necessarily be completed. Users of the research results, the researcher, and others involved in the research process are interviewed and surveyed. Standardized forms are used to record the

data. The evaluation material is analyzed and reported to the Project Committee and the Research Advisory Committee. Project evaluation reports contain quantitative and qualitative analyses.

Agency staff comment on final evaluations and recommend improvements in the innovation and its implementation process (if applicable). Committee members recommend technology transfer opportunities and further research on the same or related topics.

The research unit applies these recommendations to future research, technology transfer and innovation, and program evaluation. If additional research is recommended, the research unit may identify the problem for the next annual program or incorporate it into the current year's program.

COMMENTARY:
Timing and reporting details should be added to the discussion; see the sections below. Specify when the evaluation should be completed, how long the reviewing bodies have to make comments and recommendations, and any specific policies that govern the effort. The research unit should standardize reporting to streamline the paperwork that is part of the evaluation process. Although the research unit is given the lead in the project's final evaluation, the Project Committee can be substituted. The following sections would be modified accordingly.

A.1 Research Staff Review

Project evaluation is assigned to a research unit staff member who conducts the evaluation according to the prescribed methods.

COMMENTARY:
Methodology is prescribed in this section or in a subsection immediately following it. Included are as follows:

- *Interview protocol or survey instruments for gathering information from researchers and users or potential users,*
- *Deadlines,*
- *Level of effort (small projects will not receive the same amount of effort as large projects),*
- *Report format, and*
- *Disposition of the report upon completion.*

A.2 Agency Feedback

Selected agency personnel participate in project evaluations. They are individuals who influence implementation of the project results and recommend improvements in the research program. Members of the Research Management Committee and others in the Agency may be

asked to participate in the evaluation process. Research staff members respond to Agency participants' specific suggestions and recommendations.

COMMENTARY:
The groups or agency personnel giving feedback on the evaluation should be specified. The documentation each group gets also should be detailed (the more senior management may get higher-level material, while project-level staff may have all support documentation). Deadlines for review should be specified. Treatment of comments and recommendations should be discussed, including specifics on how the research unit comes to closure on the feedback provided by others in the agency.

A.3 Project Committee Input

The Project Committee is uniquely qualified to make recommendations and suggestions regarding the performance of the research and the relevancy of the results of the research effort. Project Committees regularly supply information for the final project evaluation, either in a final evaluation form to be filled out by each committee member or through a consensus recommendation by the committee formulated during one of its regularly scheduled meetings.

COMMENTARY:
Providing opportunity for the members of the Project Committee to comment and make recommendations about the project is most important. They are very familiar with the project and have a vested interest in the successful outcome of the research.
The means by which the committee or committee members' comments and recommendations are solicited are at the discretion of the research unit. For instance, the final evaluation can be an excellent agenda item for the committee toward the end of the formal committee's functional responsibilities.

10.1.2.B Process External to Agency

At the discretion of the research unit, the Project Committee, or the Research Advisory Committee, the project may be evaluated by others outside of the agency. The evaluation may be performed through contract, by organizations affected by the research, or by research peers in other agencies. External project reviews concentrate on research methodology validity, data collection and analysis, and research results.

COMMENTARY:
Project evaluation by others outside the agency may be used for particularly large, sensitive projects or for difficult research projects. Specify who or which group can request such an external evaluation. Details of this process could be included.

10.1.2.C Economic and Quantitative Process

To measure research project performance and benefit, economic and other quantitative analyses of varying sophistication are performed according to project size and available data. These analyses include net savings of dollars, time and lives; cost-to-savings comparisons; cost-benefit; present value; and return on investment.

Data must show the conditions within the agency before and after the implementation of the innovation. The research unit requests the following data from the operating unit:

- Reduction in life-cycle costs (direct savings over the extended life of the new technology),
- Agency labor costs/savings (direct costs/savings or changes in numbers of employees used to accomplish the same result),
- Agency materials costs/savings (direct costs/savings or changes in the amount of material to accomplish the same result),
- Agency equipment/facilities costs/savings (direct costs/savings or changes in use of equipment and facilities),
- Numbers of installations and extent of implementation,
- Consulting engineering/other outside technical costs/savings,
- Contractor costs/savings,
- Changes in personal injuries,
- Changes in fatalities,
- Changes in property damage or maintenance,
- Changes in environmental quality (cleaner and quieter), and
- Changes in motorist delay.

COMMENTARY:
Add any data element that may be used for analysis to the list contained in this section.
Economic analyses are data driven. If the data do not exist, it is difficult to arrive at defensible statistics. The research unit manager must assess the data availability before committing to perform any analysis. Operations units do not ordinarily keep records of the information listed; unless arrangements can be made at the start of the research and implementation efforts for data collection and retention, other methods of evaluation must be used. There are two schools of thought regarding quantitative analyses for research activity benefits. One group argues there are too many suppositions regarding data and too many unknowns regarding benefits. This group holds that the costs generally are overstated and the benefits are understated. The second group maintains that benefits analyses can be performed and that benefit/cost and net present value determinations are acceptable methods.

While complex methodologies may not be appropriate for every project or every research unit, some basic comparisons to costs and anticipated benefits may be possible.
If data are not available, qualitative analyses may be appropriate.
The research unit determines whether a quantitative or qualitative analysis is used. Is there technical expertise in the research unit to do the analysis? Which methodology properly answers the questions asked regarding the value of the research project. Are the data available from the operating units? Which data are critical to measure?
Articles on quantitative evaluations and benefit/cost calculations are included in the bibliography.

C.1 Benefit/Cost Analysis Methodology

The general types of data required for the benefit/cost analysis are listed in the preceding section. Topics requiring special consideration for each benefit/cost analysis are defined as follows:

- The project's effect can range from the Agency to the country.
- The interest rate is influenced by the economy, its projected future direction, and the philosophy of the Agency.
- The factors requiring assessment are internal, external, and secondary (some of the more common items are listed in 10.1.2.C, above).
- Overcounting (or double counting) can be problematic with certain factors.
- The lives of different elements are not similar.
- Multiple-use projects may show limited benefits to different factors.
- Some effects of the implementation may be judged a benefit and a cost.

COMMENTARY:
The specific evaluation methodology used by the research unit or the agency should be inserted here. A discussion of the premises governing the methodology should be given as well as the data required for the analysis. The output of the methodology should also be discussed, as well as format, applications, data limitations, and similar details.
Articles on benefit/cost calculations are included in the bibliography.

C.2 Net Value

In addition to determining a benefit-to-cost ratio of the results of the research, research benefits are quantified. This value is expressed as the net effectiveness of the research effort. Did the research save the agency money, time, or lives—and if so how much? Quantification of the benefits, less the costs, yields the net value. Appropriate inflation/discounts are factored into the calculations. Data required for the quantitative analysis are listed in Section 10.1.2.C above.

COMMENTARY:
The use of standard net present value methods are discussed in the Transportation Research Circular 426, "The Scientific Approach to Research," cited in the bibliography.
The most important aspects are as follows:

- *Will implementing the innovation further the mission of the Agency effectively?*
- *Will money, time, or lives be saved by putting the process, method, or product into practice?*

10.1.2.D Qualitative Process

Qualitative evaluation of the performance and the results of the research project provides valuable information. For research project results, qualitative evaluations focus on the following:

- Conformance to expected performance of the product, process, or method;
- Ease of application of the product, process, or method; and
- Qualitative improvement in operation, function, or management information.

Qualitative evaluations are conducted through written or personal interviews that track research results incorporated into the agency's standard plans, specifications, practices, or procedures, and their effect.

Qualitative evaluations are also conducted for the research project process, concentrating on the following:

- Adherence to appropriate research methods,
- Timeliness of the effort,
- Technical excellence,
- Fulfilling the scope of the effort, and
- Performance within budget.

In addition, the administrative processes used by the agency are reviewed to determine if improvements could be made for future research efforts.

COMMENTARY:
A survey or some other interview instrument is generally used to evaluate the quality of the overall research effort. A checklist can be included in this section showing the basis for a qualitative evaluation. A personal interview can be the best way to clarify ambiguities.

Data from implementation evaluations may provide useful information. Some of the questions to be asked are as follows:

- *Is the process, method, or product performing as anticipated? If yes, how? If not, why?*
- *Are users' needs being met as anticipated? If yes, how? If not, why?*
- *What is the extent of the implementation?*
- *Have benefits and objectives been met?*

Other questions for user interviews include: "Did the research ..."

- *Reduce the necessity for overbuilding or provide for more rational design?*
- *Allow more effective use of transportation resources, equipment, or facilities?*
- *Reduce risk to the agency or its employee, (either legal risk or injury)?*
- *Increase public safety?*
- *Increase customer satisfaction?*
- *Produce higher-quality services?*

Qualitative evaluations are used if data are insufficient to perform quantitative evaluations. User input significantly increases the level of credibility of a qualitative evaluation.

The research unit, the researcher, and any users involved with the research should be interviewed/surveyed to determine research performance as detailed in the narrative above. Other areas for evaluation should be described in this section.

Consistency in data collection (e.g., interviewing) is critical when performing qualitative evaluations because the answers given are subjective. If qualitative evaluations are performed, the research unit should have a written protocol for interviewing/surveying the research project participants.

10.1.3 Product

The usefulness of research projects is objectively determined by final project evaluations. The final evaluation products are reports. Draft reports are circulated to project committee members, researchers, users, and any other appropriate individuals who may have input for evaluation documentation. Final evaluation reports are submitted to the Research Advisory Committee. They are used for the research unit program evaluation process.

COMMENTARY:
A general outline of a project final evaluation report can be included in this section. Reports should contain the following:

- *Scope and purpose of the research;*
- *Researcher or research organization, cost, and time to complete;*
- *Brief discussion of the conduct of the research and the research methodology;*
- *Research results, conclusions, and recommendations, including continuation or follow-up research;*
- *Implementation and technology transfer activities, results to date, and future expectations;*
- *Evaluation—qualitative and quantitative; and*
- *Overall assessment.*

SECTION 11.0 PROGRAM EVALUATION

11.1 Overall Program Performance

11.1.1 Purpose

Expenditure of public funds is subject to careful scrutiny. Because the profit motive does not exist in the public arena, public programs that receive funds must prove their value in other ways. After careful selection of projects from problem statements and development of the work program, the research effort follows scrupulously defined procedures that ensure unbiased, meaningful results. Projects are evaluated to assess the cumulative effect of the program as a whole.

11.1.2 Process

The overall performance of the research program is a summation of all of the components of the program. The success of the individual research projects, technology transfer effort, and implementation of research results are good indicators of overall program performance. The research unit keeps accurate records on all of its activities, costs, and accomplishments. Several parameters are used to evaluate overall program performance: success of implementation and technology transfer activities, milestones, funding and schedule adherence, benchmarking, peer exchange, and satisfaction of customer and management needs.

> *COMMENTARY:*
> *This aspect of program evaluation involves considerable record-keeping. As with previous sections of the guide, the research managers are reminded that they should be selective in their choice of subsections and content.*
> *The section on implementation results is too important to the research program to omit and FHWA regulations require a tracking effort. The easiest method of tracking may be quarterly tabulations. Actual items to be tracked should be selectively chosen by the manager. Implementation steps should also be documented. Section 11.3 covers the success of implementation in the program.*
> *The section on Milestones is actually an activities list. Although not all of the suggestions may be necessary, they show the range of effort for the research unit.*
> *The data collected for the Funding and Schedule Adherence subsections are necessary to satisfy the requirements of the FHWA. The cyclical report (quarterly, semiannual, or annual) for each project can be the means of transmitting this information to the FHWA. Tracking program funds involves the accounting unit of the agency.*

The last section, Benchmarking, is an attempt to put generalized data for the research unit into a performance setting. This is not mandatory, but the research manager should consider some aspect of benchmarking. All suggestions may not be appropriate for an individual research unit.
This section on overall program performance lists several project achievement areas of the program. To give the most accurate picture of the research unit's accomplishments, the items should be combined. Forms 7.2 A, B, and C can be used.

11.1.2.A Implementation Results

Implementation of individual projects is discussed in Section 9.0, Implementation Process. Combining the summaries of the individual projects documents the progress for the entire program. The summaries include the actions at the following times:

- During project work plan preparation,
- At all project meetings,
- During project field visits, and
- At any specific implementation meeting.

In addition to the tabulations listed, partial- or full-project implementations are documented. Although a project may have been completed, subsequent implementation achievements are documented as they occur. Form 7-2 A, in the Appendix, is used for this purpose.

11.1.2.B Milestones

The work program provides a the summary of all research activities planned for the year: projects, technology transfer efforts, technical assistance, seminars, and implementation efforts. Milestones for these activities include the following:

- Project reports (refer to section 7.1, Project Level Reporting),
- Design of field installations,
- LTAP meetings or presentations,
- Field inspection visits for technical assistance,
- Public technical meetings and seminars (refer to section 2.4, Developing Customer Support), and
- Information dissemination.

Attainment of each of these milestones is documented.

COMMENTARY:
Achievement of milestones may also result in technical accomplishments, as defined under 7.1, Project Level Reporting. Repetition isn't required in this section.

11.1.2.C Funding Adherence

Each funding source in the work program has a fiscal year limitation and each activity has a specific budget. A record of both the funding source and budgeted project expenditures is kept. Allowances are made for overexpending on the individual SPR projects for the year, but the total program funds for SPR or other funding sources cannot be exceeded. Individual project overruns are documented.

11.1.2.D Schedule Adherence

Projects are the most important scheduled activities. Most other activities can be planned throughout the year. Adherence to the project schedule is contingent on many factors, so the principal investigator and unit manager must be in frequent communication to avert major slippage.

Quarterly reports compare the planned to the actual project progress. A tabulation shows the number of projects that are ahead of, on, and behind schedule. Qualifying statements are made for those projects that are behind schedule. Form 11-1 in the Appendix is used for this purpose.

11.1.2.E Benchmarking

The achievements of the research program cannot be easily shown on a total performance basis—the diversity of the activities is too great to permit their summation;however, the quality of the program can be judged by observing, over time, the progress of some of the measurable parameters. Benchmarking demonstrates research progress and shows quality changes. Some of the factors that are benchmarked to show the performance of the program are as follows:

- Programmed funds,
- Staff research projects,
- Contract research projects, and
- Milestones achieved.

COMMENTARY:
Benchmarking results in the comparison of similar information and requires considerable attention to data collection. The factors suggested above can be best compared on an annual basis; other factors may be compared on a semiannual or biennial basis, but the point of benchmarking is to run a time series of the factor to judge its trend.
The selection of factors is very important. Qualification of the data is cumbersome in a graph, so the research manager must select factors that can stand on their own. It may be difficult to decide on a factor that does not have to be qualified or that can stand alone. Hence, the concept of benchmarking progress may have to be dropped as a measure of overall program performance. The factors listed above may not necessarily reflect that more is better.

11.1.3 Product

Documentation of successful performance of research is important to ensure continued management and financial support. Objective and quantifiable factors should be the basis for this support. Overall program performance is measured by a combination of the achievement of implementation and milestones and a qualified adherence to financial and scheduling limits. Because management reviews the performance measures, the measures should be presented in a concise form.

11.2 Peer Exchange

11.2.1 Purpose

A good research program is measured by its implementation of results and its timely solutions to Agency problems One technique, designed to improve the quality of the program, is a peer exchange of the management process. A team, with knowledge of state research programs, can bring its expertise to provide recommendations to enhance the research unit's performance.

> *COMMENTARY:*
> *Peer exchange is meant to assist the research staff with program performance. (Refer to Sections 7.1, Project Level Reporting, and 11.1, Overall Program Performance). FHWA mandates peer exchange in 23 CFR Part 420.207 (refer to the Appendix). The peer exchange is an activity independent of the research process, conducted with staff outside the agency. The agency can accept its reporting as it would any other report designed to improve management processes.*
> *The peer exchange process is not a process compliance review—it is intended to form the basis for states to discuss the research process among themselves and with other knowledgeable researchers. The exchange can result in a better understanding of successful practices for future use.*

11.2.2 Process

11.2.2.A Team Peer Exchange With Research Unit

A.1 Team Members

The team of at least two members may consist of representatives of FHWA, universities, TRB, the private sector, other agencies, and the research units of other states. At least two of the members of the team will be drawn from a preapproved list compiled by FHWA.

COMMENTARY:
The cost of travel of the peer exchange team may be charged against the SPR program and 100% federal funding. The state can assist the individual members with travel. University representation on the panel is based on the fact that much of the contract work performed for the state research program is accomplished by universities.

A.2 Meeting Agenda

The peer exchange team will spend at least 2 days with the research unit staff. Although the items on the agenda may vary due to requests of the team, the typical agenda covers

- Research management systems, described in the research manuals of the participants;
- Development of strategic plans;
- Scope of research programs, including all activities in work programs;
- Examples of project advancement, including the solicitation, selection, choice of researcher, project progress, and technology transfer activities;
- Discussions with clients;
- Staff, financial, and equipment resources;
- Staff training programs;
- Contracting process;
- Technology transfer and implementation; and
- Research processes of other states.

COMMENTARY:
FHWA does not have peer exchange procedures; however, the state should include a peer exchange process in its manual. If definitive guidelines are issued for the process, the state can revise its manual. If the state does not have the peer exchange process, the state will not be in compliance with the regulations.
Agendas for peer exchange meetings highlight successful research processes within the agency, but all aspects of the program should be discussed. The peer exchange meeting is scheduled regularly to look at the progress and success of each of the instituted procedures. Every effort should be made to distinguish peer exchange from audit review. Prior to the meeting, the members of the team should scan the strategic plans or their substitute, the research manuals, and the current year's work programs.

A.3 Exchange Issues

A.3.1 Program Development

a. Problem Solicitation and Selection

Peer exchange of the research process starts at the beginning of the process. Therefore, copies of the strategic plan, the solicitation letters for problem statements, and the problem statements received in the current fiscal year are made available to the team. Current lists of the members of the Research Advisory Committee and the Research Management Committee as well as the minutes of the most recent meetings, are made available to the team.

b. Work Program Process

The process for putting together a work program (which is subject to policy, financial, and management considerations) is discussed with the team.

c. Contract Research Process

Because of the magnitude of contract research, this aspect of the program warrants discussion. The team is given copies of the contract research process, including the proposal review forms, a list of recent contract projects, a list of all proposals received, the results of the proposal review process for each project, and names of all contractors selected.

COMMENTARY:

The program development portion of the peer exchange provides the team with information needed to understand the research process in each other's agencies. This research guide covers several of these items under Sections 4.1 (Research Problem Solicitation), 4.2 (Project Selection Process), 7.1 (Project Level Reporting), and 11.1 (Overall Program Performance).

Information made available to the team depends on the management plans adopted by the participating states. As in previous sections, reference to the strategic plan can be replaced with reference to the state's critical issues or the solicitation process.

As suggested in Section A.2, Meeting Agenda, FHWA requirements may not compel the states to include all issues, but a discussion of issues suggested could be beneficial.

A.3.2 Project Progress

a. Project Monitoring

Satisfactory progress and the transfer of information on research projects is essential to a good relationship with the customer. Copies of the most recent reports are made available to the team. The team also is given an agenda and the minutes of the Project Committee meetings for some selected projects. Research staff members provide details of contractor and in-house project meetings and their frequency.

Examples of project implementation results for some projects are also given.

b. Reporting

Discussions between the peer exchange team and project staff depend on the type and distribution of reports generated by a project.

COMMENTARY:
There is an expected overlap between A.3.1, Program Development, and A.3.2, Project Progress. A discussion of the program cannot be complete without including a discussion of select projects.

A.3.3 Technology Transfer

All aspects of technology transfer, as described in Section 8.0, and implementation, in Section 9.0, are discussed with the team. Examples are defined in Sections 11.3.2.A, Internal Review, and 11.3.2.B, User Feedback.

COMMENTARY:
This may be the most important aspect of the RD&T management process. Although only select projects are discussed, the research unit would be well advised, particularly with the agency's administration, to maintain a complete history of technology transfer progress for all projects. Obviously, project activities are only a portion of the technology transfer effort. All customer-oriented activities should be discussed with the team. The team's input for this activity could be most rewarding for the research unit.

A.4 Procedures

A.4.1 Administrative

a. Committee Structure

The type and membership of the committees affects the potential for the research unit to interact with other Agency units and with organizations outside the Agency. The team is given details of the committees, as defined in Section 3.3, Research Committees. The current membership, minutes from the most recent committee meetings, and the research process as it relates to the committees are provided to the team.

b. Resources

Research unit resources are best defined by staff size and budget in the work program. The current appropriation, source of funds, allocation of funds, organization chart, and explanation of the use of staff are provided to the exchange team.

c. Staff Training

The technical abilities of the research team can be defined by education and practical experience. The peer exchange team is given a list of all training programs available to staff, including state- sponsored courses, research-developed courses, FHWA courses, and university programs in transportation. In addition, the team is told how

supervisors advise staff of the training courses. A list of all personnel and their degrees, training courses, and years of experience is made available to the team.

COMMENTARY:
The administrative procedures show the extent of resources available to each of the research units. The team only can use them as guidelines because a research unit can redeploy its resources and reorganize its process as warranted. The administrative factors are not expected to be discussion issues. The RD&T management process is the only issue the team will discuss.
For those states that do not make use of a committee structure, item a., above, should be omitted. Any task forces or project groups actively involved in the program or projects should be listed.
There may be good reason to ignore the exchange of the administrative information listed. It can allow the team members to relate to the size of the programs, but there is no need to have the data, unless the team intends to examine each other's program successes.

A.4.2 Peer Exchange Report

The peer exchange team writes a report on the visit that covers all aspects of the agenda items. The report summarizes the discussions, itemizes the findings, and reiterates the successful practices discussed. Copies of the report are filed with the research unit. The research unit forwards the report to the Divisional office of FHWA.

COMMENTARY:
The team report has more significance when the research process is thoroughly discussed and there is agency support for a further review.

A.4.3 Meeting Frequency and Location

The research unit will request a peer exchange in the research office at least once every 3 years.

A.5 Agency Response

A.5.1 Analysis of Issues

The peer exchange is a vigorous effort conducted for the benefit of all participants. It is accomplished by qualified peers to improve the RD&T management process. The deliberations of the team are discussed with research staff and agency management. Every effort will be made to incorporate those practices that can improve the quality of the research process.

A.5.2 Report to FHWA

The peer exchange team provides a report to the agency. In addition, the research unit reports on the outcome of discussions with agency staff and management. The report is forwarded to the FHWA Divisional office for further discussion, at their discretion.

COMMENTARY:
If changes to the research process are made, the research manual may also have to be revised, but the guidance offered by the exchange team may only affect how procedures are carried out. The exchange process is an important aspect of FHWA regulations and important in its own right. The agency has the potential for considerable gains from an extensive and intensive review of its management system.

11.2.2.B Exchange With External Research Units

B.1 Team Members

Research unit staff members program time to serve as peer exchange team members in other states, using the same review procedures described in Section 11.2.2.A, Team Peer Exchange With Research Unit.

B.2 Travel Arrangements

The research unit allocates a staff member's expenses for an annual peer exchange trip. Travel funds are not programmed to cover the cost of other team members. If a pooled fund project is set up by FHWA to cover the costs of the peer exchange team visiting the State, the Agency will participate in the pooled fund project.

B.3 Exchange Frequency

The research unit does not expect to serve as a team member more frequently than once every 3 years. However, if other states cannot serve, or if more than one State representative is used on the teams, a research member's time is programmed annually.

COMMENTARY:
The subsections above discuss the allocation of expenses for research staff participating in peer exchanges with other states. Staff member expenses for a visit to another state are not directly billed to the agency. It is assumed that an agency would have no difficulty with contributing to an SPR pooled fund project to cover the travel costs. The research manager should make revisions to conform to the policy of the agency and the funding arrangements made by the agency.

11.2.3 Product

Peer exchange is designed to let the states collaborate formally. Staff learn from and give guidance to other agencies about the research process. This is an excellent opportunity to participate in and benefit from a nonintrusive review of the agency's research process.

The process covers the problem solicitation process, work program, contract research effort, project monitoring, project reporting, technology transfer, and implementation efforts.

The result of the exchange is a concentrated discussion of the research management process with concrete examples of good practice.

11.3 Success of Technology Transfer and Implementation Efforts

11.3.1 Purpose

An annual evaluation of the research program measures the success of the technology transfer and implementation efforts. The evaluation consists of an internal review and feedback from others in the Agency who participated in or were the beneficiaries of technology transfer and implementation.

> *COMMENTARY:*
> *The question to be answered is, "Has the research unit met its technology transfer and implementation effort goals for the year (or for whatever period is designated for the evaluation time frame)?" If no goals were set, the evaluation asks, "What accomplishments in technology transfer and implementation were made this year?" This is important because it demonstrates the research unit's performance. Did the research unit increase agency personnel knowledge regarding the technologies available to solve operational problems? Did the research unit implement research results to solve operational problems in a thorough, well-executed manner?*
> *Evaluation helps the research unit manager to assess whether sufficient resources were committed to technology transfer and implementation.*
> *Sections 8.0, Technology Transfer; 9.0, Implementation Process; and 11.1, Overall Program Performance contain information related to technology transfer and implementation activities.*

11.3.2 Process

11.3.2.A Internal Review

An internal review of the research unit's technology transfer and implementation activities is performed annually. This internal review is the research unit's assessment of the technology transfer and implementation activities during the past year. Internal review determines successful strategies that can be duplicated and recommends improvements for the others.

Internal review asks the following:

- What were the most important accomplishments in technology transfer and implementation?

- Were the technology transfer and implementation goals met for the period, and, if not, why?
- Did the participation in technology transfer activities from Agency personnel meet expectations, and, if not, why?
- Was an implementation plan done for all projects? (If not, how can these be done in the future?)
- Were the individual project implementation goals accomplished, and if not, why?
- Were sufficient funding and staff available for the technology transfer and implementation? (If not, how can this be remedied in the next period?)
- What barriers to technology transfer and implementation were encountered during the period, and how can they be overcome in the future?
- What assisted technology transfer and implementation activities during this period, and can these be augmented to make the program even more effective?

COMMENTARY:
Internal review enhances research unit effectiveness. The review may be associated with the agency's total quality program initiatives. The review should be a research unit self-assessment geared toward program improvements. Outside feedback should be sought, but the critical part of the exercise is to encourage the research unit staff to seek ways to improve the program. Improvements are cataloged annually.
Care should be taken that internal review does not just count items performed—it should assess effectiveness or quality of performance and the difference it made to the agency and its customers.
Generally, a report of activities is not expected for such an evaluation, but if significant process improvements were made, those successes should be documented and acknowledged.

11.3.2.B User Feedback

Because technology users are those most affected by the technology transfer and implementation activities, the research unit solicits their opinions regularly. A written survey is conducted periodically to determine user perception regarding the research unit's technology transfer and implementation activities and to suggest improvements.

Users are chosen from the group of agency staff and others associated with technology transfer and implementation activities performed during the period.

The user survey asks about the following:

- The degree of usefulness of the technology transfer and implementation activities,
- The most (and least) helpful activities performed by the research unit during technology transfer and implementation efforts,

- How technology transfer and implementation efforts with and without the research unit's involvement compare (What difference was there in having the research unit involved?),
- Perception of the effectiveness of the technology transfer or implementation activities (Was the technology transferred, was implementation accomplished?),
- The enhancements or eliminations to the process, and
- General comments regarding the research and technology program.

COMMENTARY:
While user feedback is important, care should be taken not to make the survey so complex and tedious that it is too much of an effort. A straightforward and relatively short survey will be easier for the users and will facilitate research unit analysis.
Careful consideration should be made in the selection of those to be surveyed. The goal of the survey is to improve the program (which should be clearly stated as the survey's purpose) and those who have the potential to make a genuine contribution should be solicited. It is not necessary to survey every person involved with every project. Personal interviews are preferred.

11.3.3 Product

The benefit of having a research program is best measured in terms of the successful transfer of technology. The research staff determines if technology is transferred by assessing users of the research. A survey of the beneficiaries of the research should highlight the efforts of the research program.

11.4 Qualitative Benefits

11.4.1 Purpose

Research program benefits have been viewed, in the foregoing subsections, from the perspective of aggregating the output of the projects, reviewing the research process with peers and implementing the innovations. Program merits can also be expressed qualitatively, that is, through nonquantifiable measures that reflect program responsiveness, management interests, and the strength and stability of the research process.

COMMENTARY:
Qualitative benefits of the research program are found in many other areas of the transportation industry beyond those listed below. This is not an exhaustive inventory of nonquantifiable benefits of research. It is offered to provoke more thought on the

subject and encourage the research manager to discover others and add to this category.
There often are many ways that the activities of the research unit, the projects, the unit's involvement with others, and the unit's technology transfer efforts positively affect those outside the unit.

11.4.2 Process

11.4.2.A Meeting Customer Needs

A.1 Agency Goals

The research program focuses primarily on the needs of the agency, as determined by the agency goals. The projects are categorized by goal. Periodically, measures are taken to develop and include problems that address all the agency's goals. Goals that do not have projects associated with them are pursued by contacting the appropriate Agency staff. Pursuing agency needs fosters enhanced professional relationships between Agency units.

A.2 Customer Involvement

All citizens and industries in the state have transportation needs. The relevant research committees can only enlist a few customers from among these citizens and industries. A continuous, active role is fostered with other units of the Agency to contact and interact with transportation users in the state, in order to elicit research needs and membership on appropriate research committees. The active roles played by transportation users outside the Agency can enhance the use of research in solving the state's transportation research problems.

A.3 Management Requirements

Whenever upper management requests special research assistance, the research program will adjust ongoing activities to give a quick response. Records of the responses are maintained. These records include the research request, the requester, the approximate level of response, and the total time to respond. Prompt responses to the agency's management can heighten their opinion of the need for research.

A.4 Functional Areas

The research unit will attempt to include all functions of the agency in its research program. Although not all functions may be included each year, an effort will be made to include all functional areas regularly. The objective of this effort is to be responsive to all aspects of the agency's operations, which may not be explicitly stated above in A.1, Agency Goals.

A.5 Problem Requesters

Requests for research are formulated and received from all areas, both internal and external to the Agency.

11.4.2.B Administrative Benefits

B.1 Funding

Adequate funding for research is sought annually. Adequate financial resources are an indication of the support and importance assigned to the program and to the research staff. In addition to the federal SPR funds, resources include other federal funds, state and private funding, and non-research staff funded from other parts of the agency or private industry.

B.2 Administrative Cost of Program

The cost of administering the research program may be higher than other programs within the agency. In addition to the program development and management requirements discussed in the manual, significant technology transfer activities must be included. Unless there are substantial changes to the administrative aspects of the program, this part of the annual budget should remain relatively constant over time.

B.3 Technology Transfer Costs

The technology transfer efforts of the research unit and of the operations staff reflect a significant investment of research funds. Costs are tracked over time. The importance of the technology transfer activity is stressed in Section 8.0, Technology Transfer.

B.4 Staff Training

The agency is the primary beneficiary of staff training and educational programs, outlined in Section 12.1, Staff Training and Education. The operational goals of the agency are enhanced by skilled staff. Training records are maintained for each member of the staff.

11.4.2.C Maintaining Research Process (Excellence)

Some of the benefits of a research program are found in the quality of the processes used to develop and report the projects. Superior products from research can be expected when the elements of the process are models of excellence, open to continuous improvement, and scrupulously followed.

C.1 Program Development

The problem solicitation, project selection, and project and program reporting aspects of the research process are discussed in earlier sections of the manual. Program development is currently being conducted in the most advantageous manner for the organization and policies of the Agency. As the research unit and process matures and changes occur in the Agency, refinements to the research process will be examined and incorporated to maintain a high level of performance.

Problem solicitation is broadened by regularly changing the membership of committees. Project selection regularly incorporates improved techniques in response to Agency-modified policies, to add to the annual research work program. Project results are reported on a regular basis.

C.2 Project Development and Conduct

The development of the project objectives and activities are achieved with input from customers and technical staff. Improvements are constantly sought. In addition, the customers' desires are always considered.

The conduct and monitoring of the research are in accordance with the suggestions described in Section 6.0, Conducting and Monitoring Research Projects. Periodic training of staff and management review of staff performance enhance project development.

C.3 Reporting

The value of the research reports is judged by the Project Committee, using the requirements and elements outlined in Section 7.0, Program Reporting. The elements listed are reviewed on a project basis for conformance to special needs of the customer. Every effort is made to modify the reports to address these needs.

11.4.3 Product

This section describes the less tangible benefits of the research program. Satisfaction of the customer and management are paramount to the continued success and growth of the program. The improvement of the research process by enhancing the quality of the product and professional ability of the staff is itself a program benefit.

SECTION 12.0 PROGRAM MANAGEMENT

12.1 Staff Training and Education

12.1.1 Purpose

The success of the research program, the usefulness of the research unit, and the growth of the research staff are enhanced through staff education and training. The work environment and influences affecting personnel must foster individual growth.

Educational and training needs are pursued for staff in the following general areas: liberal arts, communications, computers, analytical skills, strategic thinking, entrepreneurship, and group dynamics.

> *COMMENTARY:*
> *The staff, training sources, and training program categories outlined in this section reflect the range of possibilities for an agency. Each agency has its own approach to determining needs and applying resources to staff. As with all other sections of the guide, the user is advised to consider the policies of the agency in selecting education and training. Going outside the agency is also an option.*

12.1.2 Process

12.1.2.A Staff

Staff skills are important at all staff levels—researcher, technician, administrator, or clerk. Programs have been structured for each staff category. The research unit collaborates with Human Resources to ensure research unit needs are addressed. Periodic reviews of the programs are made to update the training program to reflect changing needs, technologies, and Agency policies. The training programs are on file with the Human Resources unit.

> *COMMENTARY:*
> *This subsection conveys the idea that the agency has a training program for each staff member and position. If this is not the case, it should be written to reflect that the aim of the research unit is to approach training in this manner; otherwise, training may reflect only those programs offered by the agency.*

12.1.2.B Training and Education Sources

Staff in all positions are given opportunities in most of the sources listed in B.1 through B.6.

B.1 Agency Programs

The Agency regularly schedules training courses at all proficiency levels in all staff categories. Most courses are skill-oriented. Staff are urged to attend and advance through the different levels. A list of the available training is on file in the research office.

B.2 University Degree Programs

Agency policy allows for reimbursement of staff for undergraduate and graduate courses toward a degree. Staff is urged to pursue degrees in programs related to transportation. Any accredited university or college can be attended.

B.3 National Highway Institute (NHI) Programs

FHWA organizes numerous courses in several functional areas. Course descriptions and general information to request courses and fees are available in the most recent NHI Course Catalog, which is on file in the research office. In addition, agency staff, research management, and research staff may request specific courses from FHWA.

B.4 Specialized Programs

In response to legislative mandates, policy changes, or organization revisions, the Agency develops training programs as appropriate.

The research unit may contract for the development of specialized courses to meet general or specific needs in the unit.

Organizations, such as AASHTO and the American Society of Civil Engineers, organize training programs. They are offered locally or at regional sites.

B.5 Work Experience (Job Activities)

On-the-job-training is an excellent way to promote and develop staff competence. In cooperation with the Human Resources unit, staff development programs are designed for all job categories. Supervisors are trained to judge staff needs for job assignments. Staff abilities and preferences are considered in assignments and rotations to other units in the Agency. Formal and informal staff training and education are given practical application on the job.

B.6 Seminars, Workshops, and Conferences

In addition to an exchange of information at seminars, conferences, and workshops, the benefits of group meetings to the staff are abundant. The budget accommodates several off-site meetings annually.

COMMENTARY:

More sources for staff training should be listed. The category for on-the-job-training is considered by many to be one of the most important and useful to staff. If the agency has a well-developed program to foster staff progress in this category, it would be beneficial to other agencies to be able to review it.

12.1.2.C Training and Education Categories

C.1 Technical

Technical training is the most specific and directly applicable of all training. It gives instruction on activities related to the staff functional areas.

C.1.1 Functional Areas

Select staff are offered technical training in the functional areas listed in Section 5.2.2.A., Research by Functional Area.

C.1.2 Computers

Knowledge of computer software is necessary for word processing, data management, and data analysis. In addition, projects may have requirements regarding specific software packages.

C.1.3 Equipment

The complexities of the office, laboratory, and field are eased with the application of appropriate equipment for the various tasks. Staff members are trained in the use of all equipment required to perform their work assignments.

C.2 Research Methodology

Only research engineers receive instruction in research methodology. This methodology includes the steps for empirical investigations.

C.2.1 Research Process

An overview of the steps in the research process is important to understand the appropriate scientific methods used in research. The items included in the training program are variables, the research question, related literature, levels of measurement, the population, sampling methods, research design, data collection method, design of instrumentation, statistical tests, and pilot study.

C.2.2 Research Design

The four types of research design are discussed in the training program: true experimental, quasi-experimental, nonexperimental, and historical. The method of selection of the research design and the control mechanisms and validity questions of the designs are examined.

True experimental design training examines the feasibility of assigning subjects to at least two groups (i.e., experiment and control) and discusses their designs.

Quasi-experimental design training examines the reasons that true experimental design is not possible and discusses time series and other designs.

Nonexperimental design examines the reasons that an experimental variable cannot be introduced and discusses correlational procedures.

Historical design examines the environment that exists to require an historical design and discusses sources of data for the design.

C.2.3 Data Collection and Measurement Techniques

The advantages and disadvantages of the four types of data collection are examined: interviewing, instrument administration, observation, and examination of documents and materials. Measurement techniques (which include questionnaires, rating scales, checklists, materials, equipment, and forms) are also examined and discussed for each method of data collection.

C.2.4 Analysis Techniques (Statistical Tests)

Training for staff includes basic concepts in descriptive and inferential statistics, prior to determining the statistical test for their research. The choice of the appropriate statistical test is based on several factors. In addition, detailed training is given for the chi-square test, the t-test, one-way analysis of variance, and the Pearson product-moment correlation.

C.3 Communications

Staff receive specialized training in the communication skills required by their jobs. Research engineers are trained in writing, marketing, and interpersonal communication. Technicians, clerical staff, and administrators receive writing and interpersonal communication training.

C.3.1 Writing

Effective writing skills are essential because reports are the main means by which peers become acquainted with the research and Agency management is apprised of the research unit's needs. Ambiguity must be minimized, and information must be conveyed easily.

Training in effective writing includes exercises in the following:

- Planning the effort by organizing and outlining,
- Preparing the first draft and checking for conformity to the outline, and
- Editing and revising the draft.

C.3.2 Public Speaking (Presentations)

After writing, formal and informal presentation of research findings is the most used technique for transmitting research information. Administrative staff present office needs and recommendations on procedures at meetings.

Training in effective speaking is similar to that used for writing. After preparing the presentation, as outlined in C.3.1 above, the individual speaks before an audience. This is repeated on different subjects and is always followed by instructor, audience, and video feedback.

C.3.3 Interpersonal

Staff members are constantly in contact with other researchers and personnel from other Agency units.

C.3.4 Marketing

Research staff members are implicitly responsible for marketing the products of research. In fact, the research unit usually provides one of the project champions. Complete marketing programs are not conducted by the research unit, but marketing concepts are taught to improve the implementation effort. Section 8.4, Marketing Techniques, lists those areas of marketing most useful for research staff.

C.3.5 Negotiating (Contracts)

Many projects for which the research unit is responsible are contracted, which requires the negotiation of the scope of work and contract terms with the potential contractor. Therefore, research staff training includes developing the scope of work in conformance with the needs of the agency or the customer, arriving at a reasonable project schedule and budget, and clearly defining the deliverables.

C.3.6 Creativity

Imagination and inventiveness are essential ingredients for research. Staff training distinguishes between the creative outcomes and creativity in producing the outcome. All of the elements of creative behavior are discussed and used in example form. The importance of enhancing the working environment is also discussed.

C.4 Management/Administrative

Good office operations and career advancement require special skills. Select members of staff receive formal and informal training in management and administrative techniques. Research engineers are trained in supervisory and management techniques, financial skills, Agency procedures and organization, contract monitoring, project management, and ethics. Technicians, administrators, and clerical staff receive training in supervisory techniques and agency procedures and organization.

C.4.1 Supervisory Techniques

As staff mature in their positions, they may become supervisors and need training in organizing and directing staff. This training starts immediately for research engineers and, when appropriate, for other staff.

C.4.2 Management Techniques

Increased supervisory responsibility leads to positions of management and the planning and controlling of activities by other staff. All aspects of current management philosophy are included in this program.

C.4.3 Financial

The research unit's managers prepare the unit's budgets. Research engineers prepare project budgets and track project expenses. Training in agency financial procedures is offered accordingly.

C.4.4 Agency Procedures and Organization

The policies, methods, organization charts, forms, and procedures used by the Agency to assist staff and conduct business are contained in the Policies and Procedures Manual. Staff members review these documents with their supervisors at the beginning of their careers and when the documents are amended.

C.4.5 Contract Monitoring

The research engineer and the Project Committee monitor the contractors, as described in Section 6.2, Monitoring Contract Research. Training for this activity comes most directly from on-the-job experience, combined with the appropriate technical, communications, and administrative training mentioned above. Research engineers are guided in contract monitoring by experienced staff members.

C.4.6 Project Management

The research engineer has responsibility for project management as described in Section 6.0, Conducting and Monitoring Research Projects. All research engineers advance with experience and ultimately assume the position of project manager. The foregoing training categories assist the research engineers in assuming this role.

C.5 Ethics

Research staff are judged according to a high standard of professional conduct and a strict moral code. The standard and code help ensure that the research products receive universal acceptance. Training in ethical behavior includes discussion of appropriate practices and how to avoid unethical practices in the following areas:

- Protection of researchers and research subjects,
- Consent of directly involved research subjects,
- Confidentiality of subject documents,

- Privacy of subjects,
- Anonymity of subjects,
- Research methodology,
- Reporting,
- Researcher professional involvement with subjects and industry, and
- Responsibility to management.

COMMENTARY:
Some agencies have well-developed training programs that should be identified in the manual. Some categories (e.g., creativity and ethics) may need further explanation.

12.1.3 Product

Good training is one of the most important areas to which the research and agency managers devote their time. Staff skills enhance the ability of the Agency to meet the growing demands of the transportation industry.

This section outlines skills training programs available to staff and the technical, research methodology, communication, ethics, and administrative programs that are important for the individual's and the research unit's growth.

The effect of staff training is found in the overall enrichment of staff and research program.

12.2 Management Resources

Various resources are available to assist in management of research programs. This section discusses useful organizations, publications, and contacts. Some of the resources are technical; each offers information on program issues. It is a primary responsibility of the research unit to develop these resources.

12.2.1 Organizations

Several organizations provide useful research program management materials and opportunities for peer exchange among research and transportation professionals. These organizations are as follows:

- *Conduct of Research Committee (A5001), Transportation Research Board (TRB)-- Technical Activities Division*
  This organization increases the quality and effectiveness of research through encouraging better planning, management, and operational practices in organizations engaged in transportation research. The committee assists TRB in stimulating research and serving as a national clearinghouse for research activities.

The committee is composed of 25 research and technology professionals from private, university, and public sector organizations; it has an active "friends of the committee" group that is open to anyone interested in the committee's activities. The committee sponsors sessions at the TRB Annual Meeting, holds a general committee meeting at that time, and holds periodic mid-summer meetings. Materials discussed at these meetings and personal contacts are important sources of research program management information. For further information see the annually published *TRB Directory*.

- *Research Advisory Committee (RAC) of the AASHTO Standing Committee on Research (SCOR) and the Four Regional Research Advisory Committees*

RAC provides a forum for state research directors in which they participate in AASHTO research activities and support SCOR. RAC maintains an overview of all State-related transportation research programs using federal funds and is informed of State-only funded research efforts. It provides a network in which the results of such research is shared. A national meeting of RAC is held during the TRB Annual Meeting and at a summer meeting on even-numbered years. Regional RACs are composed of the RAC membership from states within the respective four Regional Associations of State Highway and Transportation Officials. Regional RACs meet annually—within region in odd-numbered years and as an adjunct to the national RAC meeting in even-numbered years. Because of its membership, this organization is a good source of program management information.

- For additional organizations, the *RAC Handbook—A Guide for Committee Members*, is available from the TRB Cooperative Research Programs and is retained in the research office. The committees of AASHTO, TRB, ASTM, ITE, ITS, and other organizations are important to the research unit's ability to assess current thinking on issues.

COMMENTARY:
Other organizations that provide particularly good research program management resources for the research unit should be added here. If the agency itself offers program management training opportunities to the research unit, these should also be included. The description should explain the connection to the organization.

12.2.2 Publications

Research program publications related to management are described below. The bibliography in the appendix also lists publications relevant to technical transportation topics and management. The research unit retains most of the publications in its office.

- Transportation Research Board—*TRB Records*, dealing with transportation research management issues; *TRNews*, quarterly publication of TRB; and *TRB Special Reports* and *Syntheses of Practice Reports* (all NCHRP items are listed in the annual TRB Publications Catalog).
- *Public Roads Magazine*—Published by FHWA. Periodically includes program management articles.
- *Research-Technology Management Magazine*—Published by the Industrial Research Institute, Washington, DC. A very good source of general research management information. Primarily supported by private sector organizations. Most material is directly applicable to public sector research activities.
- *Research and Technology Transporter*—Newsletter published by FHWA Turner-Fairbank Highway Research Center. Occasional program management articles, mostly technical.
- Eno Foundation publications—Including *Transportation Quarterly* and other special reports.
- *Harvard Business Review* and Harvard University Press—Has general management materials.
- *Journal of Management in Engineering*—Published by American Society of Civil Engineers. Includes some articles of relevance to general program management.
- *Journal of the Technology Transfer Society*—Published by the Technology Transfer Society, Indianapolis, Indiana.
- *R&D Innovator*—Newsletter.
- Agency management training materials.

COMMENTARY:
There are numerous publications on technical transportation topics, but relatively few deal directly with transportation program management. Reports from these organizations that deal with program management are particularly relevant.
Additional sources that should be listed are publications available from the agency's reference center or library and any local universities and colleges.

12.2.3 Contacts

The research unit maintains contacts with research and research management peers throughout the nation. Primary among these are the organizations listed in Section 12.2.1 above, Transportation Research Board Conduct of Research Committee, the Research Advisory Committee of the AASHTO Standing Committee on Research, and the Regional RAC organizations. Peer exchanges increase the effectiveness of the agency's research program management.

The *RAC Handbook*, Chapters 5 and 6, list contacts for technical and program management issues as follows:

- RAC and SCOR member names and addresses,
- AASHTO staff contacts,
- National Transportation Product Evaluation Program (NTPEP) contacts,
- NCHRP staff,
- TRB state representatives,
- TRB Conduct of Research Committee membership,
- FHWA and state SHRP implementation coordinators,
- FHWA participation in technology programs,
- Highway Innovative Technology Evaluation Center (HITEC) state contacts, and
- FHWA regional research and technology engineers.

COMMENTARY:
Other professional organization contacts provide useful program management guidance and should be included in this section.

12.3 Records

Good record keeping ensures the highest level of research unit credibility. All aspects of the research program must undergo the scrutiny of technical and financial audits. Record-keeping systems conform to state and the federal government requirements.

COMMENTARY:
The text of the financial, equipment, and project data files should reflect the policies and procedures of the agency and state.

12.3.1 Financial

Agency records account for the budgeting and expenditure of staff time, staff benefits, equipment, travel, materials, administration of research, contractors, and all other charges to the projects of the research program. These records are available to the research unit monthly.

12.3.2 Equipment

All project equipment is inventoried as follows:

- Description,
- Identification number,
- Source and title,
- Purchase date,
- Cost and percentage of federal participation,

- Location of equipment, and
- Condition.

The inventory is regularly updated and maintenance is performed on all equipment. Disposition records are kept for equipment no longer used for its original project.

12.3.3 Project Data Files

All project data, correspondence, and analysis records are maintained in active files for 3 years after the closeout. Thereafter, the files are kept in inactive storage for 5 years.

12.4 Other Administrative Issues

12.4.1 PR-2.1 Form

NCHRP is supported on a continuing basis through the contribution of funds from AASHTO member departments. Each member department contributes 5.5 percent of their federal-aid SPR allocation funds. The Agency annually executes a contract with the National Academy of Sciences, National Research Council (the parent organization of TRB) for this effort and other services supplied by TRB. In addition, the Agency executes an FHWA PR-2.1 form to enable transfer of federal-aid funds directly to TRB without first going to the state. (See Appendix 12.4 for a copy of the PR-2.1 form.)

12.4.2 PR-2 Form

The PR-2 Form is the Federal-Aid Project Agreement executed in conjunction with the Agency's expenditure of SPR funds. Such forms are executed for FHWA pooled fund research efforts and various other SPR activities. (See Appendix 12.4.A for a copy of the PR-2 form.)

12.5 Patents and Copyrights

Research results may include innovations that are eligible for patents or copyrights. The research unit follows the Agency's standard policies for patents and copyrights. Provisions detailing ownership rights are included in all research contracts. Products produced by research unit staff and others within the Agency are patented or copyrighted in accordance with Agency policies and state laws. All Agency staff performing research activities are notified of these policies and laws.

> *COMMENTARY:*
> *In general, federal regulations for patents and copyrights allow the awarding agency a royalty-free, non exclusive, and irrevocable license to reproduce, publish, or otherwise use, and authorize others to use the results for federal government purposes. States generally have their own specific legal requirements. Research unit*

staff should consult the agency's legal counsel for the precise wording to be used in contracts with all outside researchers and for rules governing Agency employees performing research.
Include the precise wording used by the agency in this section.
For further information see "Federal Acquisition Regulations System," Number 48 Part 27 Subchapter E, Code of Federal Regulations *and* Code of Federal Regulations *Number 49, Part 18.34.*
All research unit employees and others within the agency performing research should be formally notified of the agency's policies and the state laws regarding patents and copyrights. A standard form could be made and distributed at the start of a project. When hiring research staff, the policies and laws governing patents and copyrights should be discussed.

12.6 Data Ownership

Ownership of research project data is in accordance with Agency policy. Provisions detailing ownership rights are included in all research contracts. Information from projects performed by Agency employees is the property of the Agency.

COMMENTARY:
In general, data belong to the awarding agency. The research unit may specify that all data must be delivered with the products of the research or be retained for a specified period by the researcher during which time the agency may access it on request. The option is detailed in all research contracts. Agency staff performing research should be informed about the agency's ownership.
It is important to coordinate this topic with the agency's legal counsel. Include in this section the precise wording used. For further information see "Federal Acquisition Regulations System," Number 48, Part 27, Subchapter E, Code of Federal Regulations.

12.7 Liability

The research unit follows Agency policy regarding liability incurred by non-Agency employees during the performance of research projects. Responsibilities are included in all research contracts. Liability for Agency staff is in accordance with Agency policies and State laws.

COMMENTARY:
It is very important to coordinate this topic with the agency's legal counsel. Each state has its own liability laws. Include the precise wording used in this section. All agency employees performing

research should be notified formally of the agency's policies and the state laws regarding employee liability.

12.8 Publication Rights

With prior approval, the research unit allows contractors to publish research-related materials. Details of publication rights are specified in all research contracts. Agency employees performing research must coordinate publication of all material with the research manager and the Agency press liaison.

COMMENTARY:
The research unit should control publication of interim or draft final research results and should strictly enforce approval of such material for publication. Standard contracts should not sanction breach of contract.
All agency staff performing research should be encouraged to publish articles relating to innovative findings of research. Publications should be well respected and technically credible forums. The research unit manager or some designated staff member should review the materials for publication. All publications of research findings performed by outside researchers or agency staff should include the agency name and other sponsors of the research.

APPENDIX

BIBLIOGRAPHY

FIGURE 1- NCHRP Fields and Areas

FORM 4-1: Research Problem Statement

FORM 5-3: Proposal Evaluation Criteria

FORM 6-1: Project Task Completion Schedule

FORM 7-1: Quarterly Progress Report

FORM 7-2A: Program Report - Highlights

FORM 7-2B: Program Report - Problems/Issues

FORM 7-2C: Program Report - Budget/Expenditures

FORM 11-1: Program Schedule Adherence

Appendix 12.4 : FHWA PR- 2.1

Appendix 12.4.A: FHWA PR-2

23 CFR, Part 420, State Planning and Research Program Administration

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Section 1.0 Purpose of Manual

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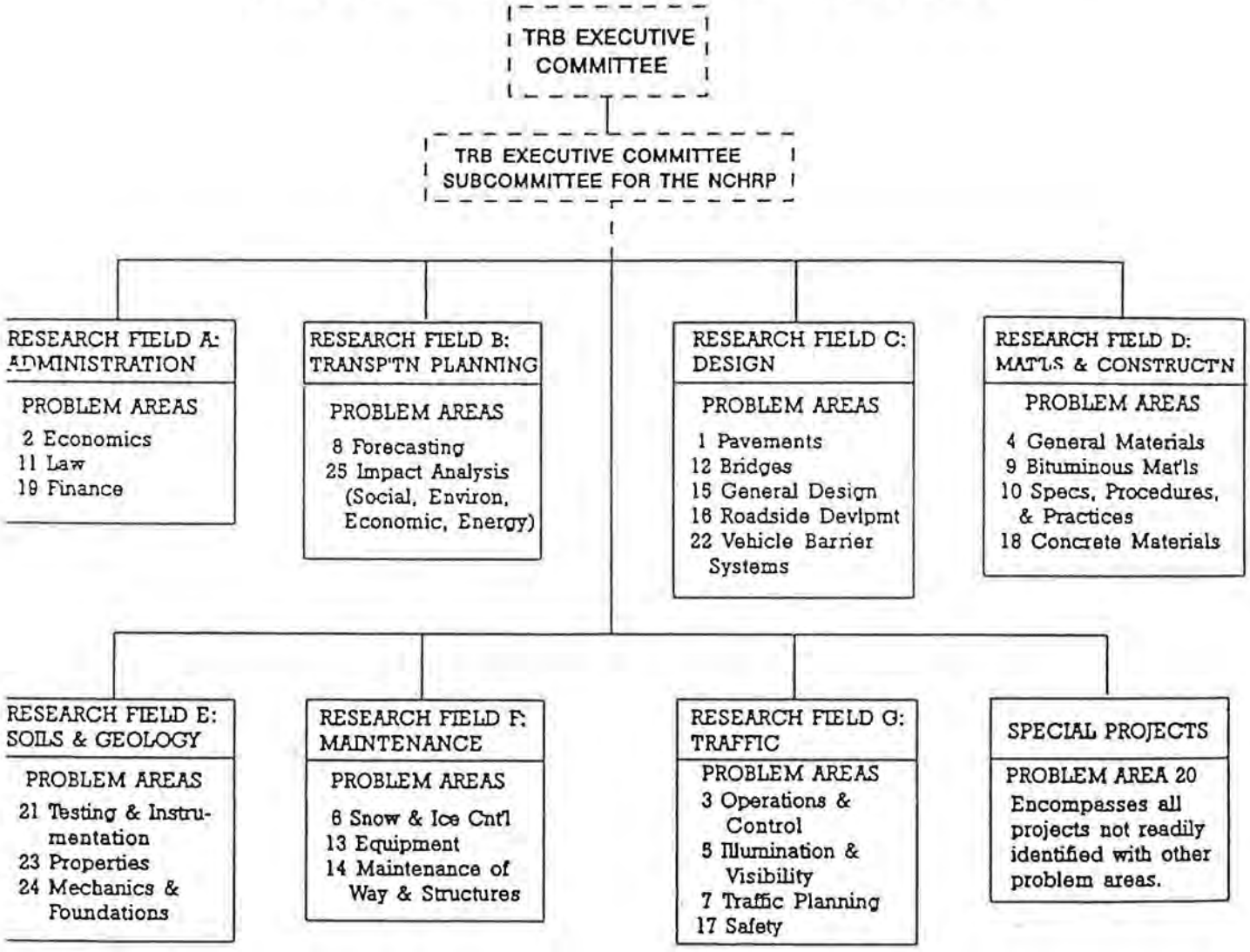
Research Manuals

FHWA RD&T Program Manual
Arizona
California
Indiana
New York
Virginia
Texas
Washington

FIGURE 1

NCHRP RESEARCH FIELDS AND AREAS



Form 4-1

RESEARCH PROBLEM STATEMENT

(Sample Form)

TITLE:	Brief but descriptive
PROBLEM STATEMENT:	Describe the problem in detail
EMPHASIS AREA:	(List the emphasis areas that were developed by the agency; if none were developed, don't include this item in the form) Check the emphasis area within which the problem falls
BACKGROUND:	Brief history of circumstances surrounding problem and a list of studies that address the problem (if available)
SCOPE OF WORK:	Description of study objectives and proposed research approach
POTENTIAL IMPLEMENTATION:	Brief description of how the results could be implemented
TIME/COST ESTIMATE:	Length of study and total study cost (If good estimates cannot be given, leave blank)
SUBMITTED BY:	Also indicate agency affiliation and phone number
DATE OF SUBMISSION:	

Form 5-3

PROPOSAL EVALUATION CRITERIA

Proposal Title: **Submitted By:**
Date of Proposal:
Reviewer:

Understanding of the Problem Score___ Weight_____%

The proposal must contain a solid knowledge of the problem and its background and not a duplication of the RFP.

Proposed Research Approach Score___ Weight_____%

A scientific and practical approach to the resolution of the problem should include: an experimental design, data collection procedures, analytical procedures, cooperative features (if necessary) and innovative concepts. A time and budget allocation of each task is required. Sufficient detail should be given for all items.

Qualifications of Staff and Firm Score___ Weight_____%

The experience and expertise of the staff should be considered, including the technical disciplines of the principal investigator and the support staff. The relative effort of staff is important. The background of the firm must also be assessed.

Adequacy of Resources Score___ Weight_____%

If the project requires support facilities, the laboratory, computing and testing equipment, test track or any other resources must be available, unless they are part of the project budget.

Implementation of Results Score___ Weight_____%

A judgement of the proposal's application of the results should be made.

Strengths and Weaknesses Not Weighted

It would be desirable to list specific strengths and weaknesses for discussion with the evaluation committee.

Overall Weighted Score___

Notes: The total of the weights should be 100%
Scores are assigned on a 10 point scale
The Overall Weighted Score is the sum of the individual multiples of score and weight

Form 6-1

PROJECT TASK COMPLETION SCHEDULE

Project Period_____

Project Task	% of Project	% Task Completed To Date	% Project Completed
Total	100		

Form 7-1

Quarterly Progress Report

Project Title: **Time Period:**

Principal Investigator:

Project Purpose:

Project Tasks, Schedule and Task Problems:

Task Milestones and Accomplishments for Period (state status of schedule adherence):

Budget and Expenditures:

	Budget	Expenditures	
		Federal*	State
Salary			
Overhead			
Travel			
Equipment			
Miscellaneous			
Total			

* (Specify source)

Form 7-2 A

PROGRAM REPORT - HIGHLIGHTS
Program Period :_____

Project Summaries (Number of Projects by Category)					
Status	**Staff**	**University**	**Private Consultant**	**Pooled Fund**	**Other**
Final Reports					
Projects Underway					
Functional Area*					

* List each of the functional areas for which there are research projects

Implementation Highlights	
Project Related	
Technology Transfer Efforts	

Total Funding**		
Source	**Programmed**	**Expended**
SPR		
State		
Other		

** This table may be repeated for each of the categories of staff, University, private consultant, pooled fund or other research.

Form 7-2 A (con't.)

Staffing		
Category	**Current**	**FY Change**
Researcher		
Clerical		
Administrative		

Milestones	
Project Related	
Technology Transfer Efforts	

Conferences/Meetings	
Item	**Description**
Conferences Arranged	
Conferences Attended	
Project Meetings	

Facilities/ Equipment (Additions and Deletions)

Form 7-2 B

PROGRAM REPORT - PROBLEMS/ISSUES
Program Period:_____

Implementation Problems	
Project Related	
Technology Transfer Efforts	

Project Problems	
Staff Research	
Contract Research	

Funding Problems	
Staff Research	
Contract Research	

Staff/Facility/Equipment Problems

Form 7-2 C

PROGRAM REPORT - BUDGET/EXPENDITURES
Program Period:_____

Budget By Source				
Source	**Appropriated**	**Budgeted**	**Expended**	**Balance**
State				
SPR				

Total Budget By Line Item			
Budget Item	**Appropriated**	**Budgeted**	**Expended**
Salary			
Overhead			
Travel			
Equipment			
Supplies			
Research Contracts			

Contract Budget By Line Item		
Budget Item	**Contracted Amount**	**Expended**
Salary		
Overhead		
Travel		
Equipment		
Miscellaneous		

Form 11-1

PROGRAM SCHEDULE ADHERENCE
Program Period:_____

Project Title	Status*			Comments** on Projects
	B	O	A	

* B - Behind Schedule
  O - On Schedule
  A - Ahead of Schedule

** Reasons for Delays; Actions to Advance Projects

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

FEDERAL-AID PROJECT AGREEMENT

(National Cooperative Highway Research Program)

1. STATE

2. PROJECT NUMBER

SECTION I—AGREEMENT PROVISIONS

In conformance with arrangements for financing the National Cooperative Highway Research Program, hereinafter referred to as the "NCHRP," pursuant to the Memorandum Agreement effective October 1, 1988 as amended, between the Federal Highway Administration, hereinafter referred to as "FHWA," the American Association of State Highway and Transportation Officials, hereinafter referred to as "AASHTO," and the National Academy of Sciences, hereinafter referred to as the "Academy"; the State formally consents to providing the funds stated in this agreement as its contribution towards financing expenditures incurred in conducting the NCHRP in accordance with the Memorandum Agreement.

In accordance with the action taken by AASHTO requesting the Academy, through its Transportation Research Board to administer the NCHRP, the State authorizes FHWA to charge the State's pro rata share of the costs incurred against the funds stated in this agreement.

It is understood that FHWA will make payments to the Academy for the State's share of the cost of the program pursuant to the State-Academy Agreement for the current fiscal year and the Fiscal Agreement entered into between the FHWA on July 1, 1962.

In the event the State's contribution towards the cost of the NCHRP is to be financed with both Federal-aid funds and State-matching funds, the State agrees to advance the FHWA the State-matching funds for its share of the estimated cost.

SECTION II—FUNDS

3. ESTIMATED TOTAL COST OF PROJECT	4. FEDERAL FUNDS	5. EFFECTIVE DATE OF AUTHORIZATION

SECTION III—AGREEMENT AND SIGNATURES

The State, through its Highway Agency, and the Federal Highway Administration agree to the above provisions.

_____
(Official Name of the Highway Agency)

BY_____

_____
(Title)

BY_____

_____
(Title)

BY_____

_____
(Title)

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

BY_____

_____
(Title)

_____
Date Executed

TO BE COMPLETED BY FHWA	U.S. Department of Transportation Federal Highway Administration **FEDERAL-AID PROJECT AGREEMENT**	STATE COUNTY PROJECT NO.

The State, through its Highway Agency, having complied, or hereby agreeing to comply, with the applicable terms and conditions set forth in (1) Title 23, U.S. Code, Highways, (2) the Regulations issued pursuant thereto and, (3) the policies and procedures promulgated by the Federal Highway Administrator relative to the above designated project, and the Federal Highway Administration having authorized certain work to proceed as evidenced by the date entered opposite the specific item of work, Federal funds are obligated for the project not to exceed the amount shown herein, the balance of the estimated total cost being an obligation of the State. Such obligation of Federal funds extends only to project costs incurred by the State after the Federal Highway Administration authorization to proceed with the project involving such costs.

PROJECT TERMINI

PROJECT CLASSIFICATION OR PHASE OF WORK	EFFECTIVE DATE OF AUTHORIZATION	APPROXIMATE LENGTH *(Miles)*
HIGHWAY PLANNING AND RESEARCH (HP & R)		
PRELIMINARY ENGINEERING		
RIGHTS-OF-WAY		
CONSTRUCTION		

OTHER *(Specify)*

FUNDS	
ESTIMATED TOTAL COST OF PROJECT $	FEDERAL FUNDS $

The State further stipulates that as a condition to payment of the Federal funds obligated, it accepts and will comply with the applicable provisions set forth on the following pages.

_____
(Official name of Highway Agency)

By _____

_____
(Title)

By _____

_____
(Title)

By _____

_____
(Title)

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

By _____
(Division Administrator)

Date executed by
Division Administrator _____

23 CFR, Part 420, State Planning and Research Program Administration

23 Code of Federal Regulations Chapter 1, Highways

Subchapter E -- Planning and Research
Part 420 -- Planning and Research Program Administration
Subpart B -- Research, Development and Technology Transfer Program Management

Section 420.201 - Purpose and applicability.

The purpose of this subpart is to implement the provisions of 23 U.S.C. 307 and to prescribe Federal assistance requirements for research, development, and technology transfer (RD&T) activities, programs, and studies undertaken by States with FHWA planning and research funds. The requirements of this subpart and subpart A of this part are applicable to work performed by the States
and their subrecipients with FHWA planning and research funds.

Section 420.203 - Definitions.

Unless otherwise specified in this part, the definitions in 23 U.S.C. 101(a) and Part 420, subpart A, are applicable to this subpart. As used in this subpart:

Applied research means the study of phenomena relating to a specific known need in connection with the functional characteristics of a system; the primary purpose of this kind of research is to answer a question or solve a problem.

Basic research means the study of phenomena whose specific application has not been identified; the primary purpose of this kind of research is to increase knowledge.

Cooperatively funded study means an RD&T study or activity, administered by the FHWA, a lead State, or other agency, that is funded by some combination of a State's contribution of FHWA planning and research funds, FHWA administrative contract funds, 100 percent State funds, or funds from other Federal agencies.

Development means the translation of basic or applied research results into prototype materials, devices, techniques, or procedures for the practical solution of a specific problem in transportation.

Final report means a report documenting a completed RD&T study or activity.

Intermodal RD&T means research, development, and technology transfer activities involving more than one mode of transportation including transfer facilities between modes.

National Cooperative Highway Research Program (NCHRP) means the cooperative RD&T program directed toward solving problems of national or regional significance identified by States and the FHWA, and administered by the Transportation Research Board, National Academy of Sciences.

Peer review means a review conducted by persons who are knowledgeable of the management and operation of RD&T programs. This may include but is not limited to representatives of another State, the FHWA, American Association of State Highway and Transportation Officials, Transportation Research Board (TRB), universities or the private sector.

RD&T activity means a basic or applied research, development, or technology transfer project or study.

Research means a systematic controlled inquiry involving analytical and experimental activities which primarily seek to increase the understanding of underlying phenomena. Research can be basic or applied.

Technology transfer means those activities that lead to the adoption of a new technique or product by users and involves dissemination, demonstration, training, and other activities that lead to eventual innovation.

Transportation Research Information Services (TRIS) means the TRB-maintained computerized storage and retrieval system for abstracts of ongoing and completed RD&T activities, including abstracts of RD&T reports and articles.

Section 420.205 - Policy.

(a) It is the FHWA's policy to administer the RD&T program activities utilizing FHWA planning and research funds consistent with the policy specified in 420.105 and the following general principles in paragraphs (b) through (g) of this section.

(b) State transportation agencies shall provide information necessary for peer reviews.

(c) States are encouraged to develop, establish, and implement an RD&T program, funded with Federal and State resources, that anticipates and addresses transportation concerns before they become critical problems. To promote effective utilization of available resources, States are encouraged to cooperate with other States, the FHWA, and other appropriate agencies to achieve RD&T objectives established at the national level and to develop a technology transfer program to promote and use those results.

(d) States will be allowed the authority and flexibility to manage and direct their RD&T activities as presented in their work programs, and to initiate RD&T activities supported by FHWA planning and research funds, subject to the limitation of Federal funds and to compliance with program conditions set forth in subpart A of this part and 420.207.

(e) States will have primary responsibility for managing RD&T activities supported with FHWA planning and research funds carried out by other State agencies and organizations and for ensuring that such funds are expended for purposes consistent with this subpart.

(f) Each State shall develop, establish, and implement a management process that ensures

effective use of available FHWA planning and research funds for RD&T activities on a statewide basis. Each State is permitted to tailor its management process to meet State or local needs; however, the process must comply with the minimum requirements and conditions of this subpart.

(g) States are encouraged to make effective use of the FHWA Division, Regional, and Headquarters office expertise in developing and carrying out their RD&T activities. Participation of the FHWA on advisory panels and in program review meetings is encouraged.

Section 420.207 - Conditions for grant approval.

(a) As a condition for approval of FHWA planning and research funds for RD&T activities, a State shall implement a program of RD&T activities for planning, design, construction, and maintenance of highways, public transportation, and intermodal transportation systems. Not less than 25 percent of the State's apportioned SPR funds shall be spent on such activities, unless waived by the FHWA, in accordance with the provisions of 420.107. In addition the State shall develop, establish, and implement a management process that identifies and implements RD&T activities expected to address highest priority transportation issues, and includes:

(1) An interactive process for identification and prioritization of RD&T activities for inclusion in an RD&T work program;

(2) Utilization, to the maximum extent possible, of all FHWA planning and research funds set aside for RD&T activities either internally or for participation in national, regional pooled, or cooperatively funded studies;

(3) Procedures for tracking program activities, schedules, accomplishments, and fiscal commitments;

(4) Support and use of the TRIS database for program development, reporting of active RD&T activities, and input of the final report information;

(5) Procedures to determine the effectiveness of the State's management process in implementing the RD&T program, to determine the utilization of the State's RD&T outputs, and to facilitate peer reviews of its RD&T Program on a periodic basis and;

(6) Procedures for documenting RD&T activities through the preparation of final reports. As a minimum, the documentation shall include the data collected, analyses performed, conclusions, and recommendations. The State shall actively implement appropriate research findings and should document benefits.

(b) Each State shall conduct peer reviews of its RD&T program and should participate in the review of other States' programs on a periodic basis. To assist peer reviewers in completing a quality and performance effectiveness review, the State shall disclose to them information and documentation required to be collected and maintained under this subpart. Travel and other costs associated with peer reviews of the State's program may be identified as a line item in the State

work program and will be eligible for 100 percent Federal funding. At least two members of the peer review team shall be selected from the FHWA list of qualified peer reviewers. The peer review team shall provide a written report of its findings to the State. The State shall forward a copy of the report to the FHWA Division Administrator with a written response to the peer review findings.

(c) Documentation that describes the management process and the procedures for selecting and implementing RD&T activities shall be developed and maintained by the State. The documentation shall be submitted by the State to the FHWA Division office for FHWA approval. Significant changes in the management process also shall be submitted by the State for FHWA approval. The State shall make the documentation available, as necessary, to facilitate peer reviews.

Section 420.209 - RD&T work program.

(a) The State's RD&T work program shall, as a minimum, consist of an annual or biennial description of activities and individual RD&T activities to be accomplished during the program period, estimated costs for each eligible activity, and a description of any cooperatively funded activities that are part of a national or regional pooled study including the NCHRP contribution. The State's work program should include a list of the major items with a cost estimate for each item.

(b) The State's RD&T work program shall include financial summaries showing the funding levels and share (Federal, State, and other sources) for RD&T activities for the program year. States are encouraged to include any activity funded 100 percent with State or other funds.

(c) Approval and authorization procedures in 420.115 are applicable to the State's RD&T work program.

Section 420.211 - Eligibility of costs.

(a) Unless otherwise specified in this section, the eligible costs for Federal participation in 420.113 are applicable to this part.

(b) Costs for implementation of RD&T activities in conformity with the requirements and conditions set forth in this subpart are eligible for Federal participation.

(c) Indirect costs of a State transportation agency RD&T unit are allowable to the extent specified in 420.113(b).

(d) Indirect costs of other State agencies and organizations are allowable if supported by a cost allocation plan and indirect cost proposal in accordance with OMB requirements.

Section 420.213 - Certification requirements.

(a) Each State shall certify to the FHWA Division Administrator before June 30, 1995, that it is complying with the requirements of this subpart. For those States unable to meet full compliance by June 30, 1995, the FHWA Division Administrator may grant conditional approval of the State's RD&T management process. A conditional approval shall cite those areas of the State's management process that are deficient. All deficiencies must be corrected by January 1, 1996. A copy of the certification shall be submitted with each work program. A new certification will be required if the State significantly revises its management process for the RD&T program.

(b) The certification shall consist of a statement signed by the Administrator, or an official designated by the Administrator, of the State transportation agency certifying as follows: I (name of certifying official), (position title), of the State (Commonwealth) of ____, do hereby certify that the State (Commonwealth) is in compliance with all requirements of 23 U.S.C. 307 and its implementing regulations with respect to the research, development and technology transfer program, and contemplate no changes in statutes, regulations, or administrative procedures which would affect such compliance.

(c) The FHWA Division Administrator shall determine if the State is in compliance with the requirements of this subpart.

Section 420.215 - Procedure for withdrawal of approval.

(a) If a State is not complying with the requirements of this subpart, or is not performing in accordance with its RD&T management process, the FHWA Division Administrator shall issue a written notice of proposed determination of noncompliance to the State. The notice shall set forth the reasons for the proposed determination and inform the State that it may reply in writing within 30 calendar days from the date of the notice. The State's reply should address the deficiencies cited in the notice and provide documentation as necessary.

(b) If the State and Division Administrator cannot resolve the differences set forth in the determination of nonconformity, the State may appeal to the Federal Highway Administrator.

(c) The Federal Highway Administrator's action shall constitute the final decision of the FHWA.

(d) An adverse decision shall result in immediate withdrawal of approval of FHWA planning and research funds for the State's RD&T activities until the State is in full compliance.