

B

THE RESEARCH PROCESS - DETAILS AND EXAMPLES

Introduction

The purpose of this appendix is to provide greater detail, and a number of examples, of some of the activities described in Chapter Three. Most of the sample documents have been taken from the National Co-operative Highway Research Program. These documents can be modified relatively easily to suit the requirements of other programs.

Problem Statement Development

The format of the problem statements used by AASHTO to select projects for inclusion in the National Co-operative Highway Research Program is as follows:

- Problem Title
- Problem
- Objective
- Key Words
- Related work
- Urgency/Priority
- Cost
- User Community
- Implementation
- Effectiveness

The title should be succinct. A title, which is vague, may result in a project not receiving due consideration. A title that is too long not only obscures the problem but also complicates cataloguing and databases, which frequently limit the number of characters in each field.

The Problem section justifies the need for the project. The initial justification of the project is generally only the beginning in the understanding of the research problem. All research activities should be couched within "Further understanding the problem or problems." This concept provides the "Big Picture" that justifies and unites all the activities and purposes of the research project. Without this concept, research programs run the high risk of failure from investing in solutions searching for problems, or allocating resources to problems that are already well understood. Problems needing research should be redefined and better understood as a matter of course throughout a successful research project. Without constant refinement of the research problem itself, finding effective solutions and implementable recommendations is elusive.

Researchable problems may be discovered in the problem statement phase. Some initial problem descriptions may not turn out to be researchable. Some may not be true problems. Many requests may be referred to operations or planning units for assistance. If a problem is thought to be worth research investment, hopefully, after further discussion, literature syntheses, surveys, pilot studies, experiments, development, etc. the problem can be better understood, and a useful result can still be offered. It is for these reasons that some successful research projects employ multiple lines of investigation, hoping that at least some of them will be useful for different aspects of the problem.

The problem section typically consists of one to three paragraphs describing the problem, and explaining why it should be solved. The section should include background information on current practices and why they are deficient. It is important to provide information on the magnitude and extent of the problem. For example, whether the problem is a serviceability issue or a safety issue, and whether it occurs at the local, regional or national level. Wherever possible, it is useful to provide baseline data, e.g. number of accidents, or cost of failures. It is often appropriate to place limits on the scope of the project by indicating what form the solution should take, e.g. a specification, report, test method, design procedure, computer program, or a piece of equipment. A very useful test of whether a problem can be solved by research is that, if the form of the solution can be defined, the problem is researchable.

The purpose of the Objective section is to state very clearly what products are expected from the research. The ability to define products that will resolve the problem, are attainable, and can be implemented, has a major impact on the likelihood of success.

Key words are used for indexing, and also for conducting a literature search to determine if related research is underway elsewhere. The section on related work provides an opportunity for the proposer to identify other work that is in progress or proposed in other research programs. Frequently, a research project will build upon the results of a project completed recently. It is unlikely that the results of the project will have been recorded in electronic databases, and would not be discovered by reviewers unless the proposer draws attention to the study.

Urgency/Priority provides an opportunity for the proposer to explain why the research needs to be initiated soon, and the consequences of a delay.

In the NCHRP process, problem statements include the cost, but not the duration of a project. Cost is required to estimate the benefit-cost of projects during the project selection phase. Other considerations, including cost, are discussed in the section 'Request for Qualifications and Proposals'. Some agencies do include an estimate of time required for the work in the problem statement. This also provides an indication of the anticipated scope of the work, especially if fieldwork is envisaged, and permits annual budgets to be prepared for multi-year projects.

The User Community section is intended to identify groups who would benefit from the research and be affected by implementation of the findings. The Implementation section is necessary to identify how the results will be implemented. It is essential that an implementation strategy be developed before research work is initiated. This allows those who will be affected by the implementation to make necessary plans and ensures that, if successful, the results of the research will be in the form required by the users. The statement of effectiveness describes the anticipated state-of-the-practice after the results of the research have been implemented. In other words, it describes the benefits of undertaking the research so that those involved in the selection of projects can estimate the benefit-cost ratio. Where possible, the anticipated benefits should be expressed in the same units as the baseline data in the Problem section.

Because of the size of the program, and its large constituency, the NCHRP uses a two-stage process for developing problem statements. The first step is the documentation of ideas. These are then processed by NCHRP and FHWA staffs to provide feedback to the submitters in the form of a literature search, and identification of work in progress and related problem statements. It is the responsibility of the submitter to determine whether to prepare a second stage proposal, which must contain all the sections, described above. An example of a completed research problem statement is given in Figure B-1.

**PERFORMANCE SPECIFICATION
FOR
BRIDGE DECK WATERPROOFING MEMBRANE SYSTEMS**

Problem

Waterproofing membranes can be an effective method of protecting both the concrete and embedded reinforcement in new and existing bridge decks. Except for a few states, membranes are used only sporadically in the United States, often to provide only a short extension of service life on existing decks. A recent NCHRP synthesis report (Synthesis 220, "Waterproofing Membranes for Concrete Bridge Decks") notes that North American practice has changed little in the past twenty years. The vast majority of membranes installed in the U.S. are preformed products, and the market is dominated by three products introduced in the 1970's. A 1995 FHWA scanning tour of bridge technology in Europe observed the broad range of materials and widespread use of waterproofing systems in protecting bridge decks in aggressive environments.

The waterproofing membrane is only one component of waterproofing system that may include primers, adhesives, protection board, tack coat and bituminous concrete layers. The performance of the system is determined by the complex interaction of material factors, design details, and quality of construction. Research is required to derive performance requirements for waterproofing systems, to be followed by development of a suite of quantitative prequalification tests and quality assurance procedures, the findings to be embodied in a performance specification. The specification should cover the material requirements for the membrane, adhesives, and protection board (if used), together with requirements for installation. The performance specification should also include provision for life-cycle costing so that systems that offer superior performance can compete on an equitable basis with systems that have low initial cost, but a short service life.

Objective

Develop a performance specification for bridge deck waterproofing membrane systems based on a quantitative definition of performance requirements, objective prequalification tests, and a life-cycle cost analysis. The objective is to encourage competition between a wide range of products and processes, all of which will perform satisfactorily in the field.

Key Words

bridge decks, concrete, corrosion protection, waterproofing

Related Work

NCHRP Synthesis of Highway Practice 220 "Waterproofing Membranes for Concrete Bridge Decks"

Urgency/Priority

The research is needed to utilize the latest technology in bridge deck waterproofing systems, to provide states with an alternative method of corrosion protection, and to stimulate development and competition in the private sector.

Cost

\$450,000 over three years

User Community

Bridge owners, designers, materials suppliers and contractors would have an interest in this project.

Implementation

The research project would result in the development of a specification to be submitted for incorporation in the AASHTO Specifications

Effectiveness

This project would provide states and local agencies with a wide choice of waterproofing systems of known service life, and an assurance of satisfactory field performance. In view of the growing lack of confidence in some other methods of deck protection, another viable option for corrosion protection is needed urgently. This would result in more effective use of limited funds available for the construction and maintenance of bridges.

Figure B-1: An Example of a Research Problem Statement

Project Selection

There are a number of ways of ranking individual projects for the purpose of developing the research program. In many agencies, the responsibility rests with an advisory committee, comprising representatives of the client groups. Typically each member of the committee will review all the research problem statements independently, discuss them with colleagues, and rank them according to some or all of the criteria given in Chapter Three. The ranking may be complex, involving weighting the criteria, or it could be simple three (0,1,2 or low, medium, high) or four (0,1,2,3, or no need, low, medium, high) point ranking. This simple approach works well when there are a large number of problem statements to consider, and the size of the program is such that most will not be selected. In situations where only a small number of problem statements are to be considered, a ranking procedure involving a greater number, and weighting, of the selection criteria may be justified.

Requests for Qualifications or Proposals

As noted in Chapter Three, a Request for Qualifications (RFQ) is normally used in one of two situations:

1. When the work activities are known and the sponsor wishes to hire qualified people to complete the work.
2. As the first step before issuing a Request for Proposals (RFP).

An example of the first situation is given in Figure B-2. The RFQ provides an introduction describing why the work is being undertaken and the specific duties of the contractor. It also provides details of the format required for the response, selection criteria, time and schedule, and administrative details.

The format of an RFQ issued to screen respondents prior to issuing an RFP is very similar to that used in the first situation. The RFQ normally states the nature and scope of the work in general terms, and requests recipients to describe the qualifications and availability of key personnel, facilities, and prior experience in related work. It is common to limit the number of pages for the response.

An example of a Request for Proposals is given in Figure B-3. The RFP is an amplification of the research problem statement, with the addition of a schedule and administrative details. Because the NCHRP utilizes project panels, comprising individuals who are themselves technical experts in the field of study, RFP's usually provide details of the tasks which the panel views necessary to complete the research successfully. Other research programs are less specific, and define the problem and solution desired, without stating the approach that is expected.

National Cooperative Highway Research Program

REQUEST FOR STATEMENTS OF QUALIFICATIONS AND AVAILABILITY

20-7/83

NCHRP Project 20-7, Task 83, FY '87

Guide for Snow and Ice Control

INTRODUCTION

Snow and ice control on the U.S. highway system consumes \$1.5 billion in direct costs each year. Indirect costs associated with corrosion and environmental impacts add another \$5 billion. However, a guide that maintains a systems approach to snow and ice control including the vehicle, driver, operator, equipment, materials, and practices for managing and performing the work has not yet been developed. Recognizing the potential savings, the AASHTO Board of Directors acted on recommendations by the AASHTO Standing Committee on Highways and the AASHTO Highway Subcommittee on Maintenance and approved, in November 1984, an administrative resolution to develop a comprehensive guide for use by member departments and local governments.

A comprehensive outline of the proposed guide was developed under NCHRP Project 20-7, Task 71, "Winter Maintenance Program." The Guide for Snow and Ice Control will be developed under NCHRP Project 20-7, Task 83. The Guide is not intended to specify any single specific material, procedure, material, equipment, or regulation for all programs; it will provide guidance for organizations responsible for roadway snow- and ice-control programs by presenting principles and practices for various environmental and operational conditions.

OBJECTIVE

The objective of this project is to develop a Guide for Snow and Ice Control that discusses state-of-the-art technology and practices pertaining to snow and ice control for consideration and adoption by AASHTO and other organizations responsible for roadway snow- and ice-control programs.

ANTICIPATED ACTIVITIES

The following task descriptions are intended to provide a framework for conducting the research. Upon contract award, the selected individual or organization will be requested to describe a detailed research effort that demonstrates an understanding of the project objectives and can reasonably be accomplished within the constraints of available time.

Task 1: Review the Guide outline developed under NCHRP Project 20-7, Task 71 and recommend changes that should be considered in the development of the Guide. Prepare and submit for NCHRP review and approval a plan for developing the Guide. The plan, to be submitted not later than 15 days from contract award, shall identify the proposed contents and outline the project schedule. Work on Task 2 will proceed while this plan is being reviewed.

Task 2: Collect and review relevant domestic and foreign literature, research findings and current practices relative to snow and ice control to obtain the information needed to develop the Guide.

Task 3: Develop a draft version of each Guide chapter and submit, as soon as complete, for NCHRP review. Reviewers' comments shall be incorporated in revising these chapters and in developing other chapters.

Note: Individual Guide chapters shall be prepared and submitted for review as work progresses.

Task 4: Develop and submit for NCHRP review a preliminary draft of the proposed Guide.

Task 5: Submit a final draft of the Guide that incorporates the reviewers' comments.

INVITATION

Interested parties (individuals, organizations, or companies) are hereby invited to express interest in conducting NCHRP Project 20-7, Task 83, by submitting a statement of their qualifications, approach to the work, and availability to undertake the work. Responses shall provide the following:

1. A discussion limited to 3 pages of the proposed approach for developing the Guide.
2. The qualifications of principal investigator and other key project team members pertaining to (1) snow and ice control, (2) project coordination and management, and (3) preparation of Guide documents and high-quality written material.
3. A list of estimated level of effort for the proposed study members. A total level of effort of 800 to 1,000 professional staff-hours is envisioned for this work.
4. A list of other time commitments for the proposed team members during the anticipated project duration.
5. An attached budget that details the estimated fully loaded rates of financial compensation for the proposed team members and other costs (e.g., travel, materials, and total).
6. A disclaimer statement providing information relevant to the NCHRP's need to ensure objectivity and to be aware of possible sources of significant conflicts or organizational conflicts of interest in conducting the research. For example, under certain conditions, ownership of the research agency, other organizations, relationships or proprietary rights and interests could be perceived as compromising an objective approach to the research; other such circumstances are stated to disclose any such circumstances. If there are none, this should be stated.

Secondness is vital; the requested statements must not exceed 28 pages, including any transmittal letter, title sheets, and attachments.

CRITERIA FOR SELECTION

When selecting the contractor for Project 20-7, consideration shall be given to the following factors: (1) company's understanding of the contract, goals, and

Responses (20 single-bound copies are due not later than 4:00 p.m. on December 3, 1986. This is a firm deadline, and extensions simply are not granted. In order to be considered, all 20 copies of the agency's response must be in our offices not later than the deadline, or they will be rejected.

Delivery Instructions

For private and business services such as Federal Express, DHL, UPS, etc., or for hand-carried deliveries:

PROPOSAL—NCHRP
ATTN: Dr. Robert J. Reilly
Transportation Research Board
National Research Council
Geos Building, Suite 300
2801 Wisconsin Avenue, NW
Washington, DC 20007

For U.S. Postal Service mail:

PROPOSAL—NCHRP
ATTN: Dr. Robert J. Reilly
Director, Cooperative Research Program
Transportation Research Board
2101 Constitution Avenue, NW
Washington, DC 20418

requirements of the Guide; (2) a demonstrated track record and coordination projects leading to development of products that are national in applicability to meet the project's schedule, cost, and production capability; (3) delivery of a draft and final versions of the Guide; (4) attention of an agency will be made to the Project Panel on the basis of the reviewer's demonstrated insight, experience, qualifications, and ability to meet the project objectives on an expedite.

SPECIAL NOTES

- A. Copies of the final report on NCHRP Project 20-7, Task 83, "Winter Maintenance Program" are available to reviewers by the TRB Publications Office, 2101 Constitution Avenue, N.W., Washington, DC 20418, at \$6.00, including postage. Credit orders should be made payable to Transportation Research Board. Copies be purchased using MasterCard, Visa, or Express by calling 202/334-3214, a 202/334-2515. Requests will not be after November 22, 1986.
- B. The agency selected to conduct the work required to submit a formal proposal NCHRP. The proposal should include additional comments generated during a selection process.
- C. At the NCHRP's agency, selected drafts be requested to meet with the NCHRP's representative and discuss the proposed work to determine. Expenses associated with preparation and the meeting will be reimbursable.
- D. Total contract time is expected to be 6 months including 3 months for review and final report. A contract start date of June should be assumed for the purpose of it to this invitation.

Staff Responsibility: Dr. Amir N. Hantou, 202/

Authorization to Begin Work: 1987—estimated.

General Notes

1. According to the provisions of Title of Federal Acquisition, Part 27, which is incorporated in generally stated proposals, are hereby notified that the contract award will be a firm award and will be awarded without regard to the ground of race, color, religion, sex, or status.
2. The Transportation Research Board encourages participation of small businesses, minority firms, and women's business enterprises in cost negotiations for NCHRP projects.
3. All responses become the property of the National Cooperative Highway Research Program and will be made according to the rules including the right to reject all responses.
4. It is not necessary for prospective applicants to notify the NCHRP that they do not submit a response. Until we are otherwise notified, we will assume that you are submitting a response and we will receive all future communications.

Figure B-2: An Example of a Request for Qualifications

Research Proposals

Most sponsors have specific requirements for the content and format of proposals. This ensures that all the required information is provided. Review of the proposals is simplified if a standard format is used because the reviewers know where to find specific items. The NCHRP requires that the following information be presented in order:

1. Cover
2. Summary Page
3. Table of Contents
4. Research Plan
5. Qualifications of the Research Team
6. Accomplishments of the Research Team
7. Other Commitments of the Research Team
8. Equipment and Facilities
9. Time Requirements
10. Itemised Budget
11. Co-operative features (if appropriate)
12. Appendices (if appropriate)

Complete details of content and format are provided in the booklet 'Information and Instructions for Preparing Proposals'. The following is an excerpt of the requirements (items omitted are self-explanatory or satisfy administrative requirements).

Research Plan

The research plan shall detail completely the prosecution of the research, including the submission of an acceptable final report. The plan ultimately becomes a part of the contract by reference of the proposal; therefore, it should describe, in a specific and straightforward manner, the proposed approach to the solution of the problem described in the project statement. It should be concise, yet include sufficient detail to describe completely the approach to the solution of the problem. Research methodology shall be described in sufficient detail to permit evaluation of the probability of success in achieving the objectives.

The research plan shall be subdivided into the following sections:

Introduction

The introduction to the research plan should provide a concise overview of the proposer's approach to conducting research. It should describe the manner in which the expertise and experience of the proposed team will be used in the research, and the application of special data, facilities, contacts or equipment should be presented. The Introduction should highlight the linkages of the proposed team's capabilities to the project tasks and the manner by which the proposed plan will satisfy the objectives.

Research Approach

This section will be used to describe how the objectives will be achieved through a logical, innovative, and rational scientific plan. The plan shall describe each phase or task of the research to be undertaken.

Anticipated Research Results.

The research plan for each proposal shall contain specific statements describing the anticipated research results. The results are expected to be presented in terms of the language and working tools of the practicing engineer or administrator so as to be immediately applicable to practice. Consequently, there must be specific statements of the manner in which the desired results would be reported; e.g., mathematical models, design techniques, field or laboratory test procedures, or recommendations for changes in AASHTO, FHWA, or standard highway specifications. If the nature of a project is such that it is known initially that the results will not be amenable to immediate implementation into practice, the research plan must include recommendations for the additional work necessary to reach the implementation stage.

Applicability of Results to Highway Practice.

The research plan shall include a section captioned "Applicability of Results to Highway Practice" that clearly describes how the anticipated research results can be used to improve highway engineering practices. Clearly indicate the expected audience for the research results. The writer should present the strongest case possible to convince the reviewer that the results of the research will be practical and implementable.

Qualifications of the Research Team

Name, address, telephone number, and pertinent background information must be provided for the principal investigator bearing primary responsibility for the project. The same information is required for other research team members participating to a significant degree. The proposals must describe how the research team members' academic, industrial, and/or research experience relate to the project to be undertaken.

Accomplishments of the Research Team

Proposals shall contain a summary of the past accomplishments ("track record") of the research team in the same, or closely related problem area of the project to be undertaken. This summary is to include full particulars concerning all known instances of application to practice of the agency's research results. If no such knowledge exists, it should be so stated.

Other Commitments of the Research Team

Proposals shall contain a listing of current organization and personnel commitments to other work in sufficient detail to indicate that the organization and all of the individuals assigned to the proposed project will be able to meet the commitments of the proposal. Man-hour commitments and percentage of time committed to other work for each member of the proposed research team shall be specified.

Equipment and Facilities

This section shall include a description of the facilities available to undertake the research and an itemization of the equipment on hand considered necessary to complete the research. In the event that use of the facilities or equipment is conditional, the conditions should be described. In the event that certain facilities or equipment are considered necessary to undertake the research but are not on hand, that fact should be presented. The proposer should identify any arrangements that will be made to borrow or rent necessary equipment. In the case where it is contemplated that additional equipment will be purchased under project funds, be certain that the budget item "capital equipment" indicates this.

Time Requirements

The time required to complete the research project shall be specified. Proposals will not be rejected if the proposed time does not match the time specified in the project statement. However, the agency must justify any difference. In addition, a schedule shall be included that shows each phase or task of the work, when that phase or task will begin, how long it will continue, and when it should end. The timetable should clearly delineate the points in time where project deliverables and reports are planned.

Itemized Budget

The estimated cost for the project should be based on the proposed performance period. The budget shall reflect phase and/or task costs. Lump sum estimates are not acceptable; budgets shall be itemized in accordance with the following cost categories where appropriate:

- (a) Salaries and Wages. Each employee to participate in the performance of the project shall be identified by name, with role, level of effort, and cost presented in the format specified in the terms of Figure B-4.
- (b) Borrowed Personnel. Reimbursement to other employers for salaries and wages paid by them to their employers released for, and directly engaged in, the performance of the subject research, plus federal and state payroll taxes and related employee benefit plan costs.
- (c) Consultants. Costs for services of independent consultants deemed necessary for accomplishment of the research.
- (d) Subcontract. Costs for services deemed necessary for performance of a portion of the research.
- (e) Capital Equipment. Items with a value in excess of \$500.00 per article or assembly required for the conduct of the research.
- (f) Materials and Services. Materials, supplies, and other articles, including the cost of processing, testing, rental of apparatus and equipment from others, preparing, editing and reproducing reports, including the final report.
- (g) Communications and Shipping. Long-distance telephone calls, postage, freight, etc.
- (h) Travel. Transportation costs plus reasonable actual subsistence expenses
- (i) Employee Benefit Plan Costs and Payroll Taxes. Costs of group insurance and employees' pension and retirement plans federal and state payroll taxes for employees working directly on the subject research.
- (j) Overhead. An allowance for overhead costs determined in accordance with the research agency's usual method of accounting and generally accepted accounting principles.

EXAMPLE

FIGURE 5

LEVEL OF EFFORT BY TASKS (MAN-HOURS AND COSTS)									
Names of Principal Staff Members (Include Sub-contractors & Consultants)	Role in Study	Time* (%) over Contract Period	Man-Hours				Total	Hourly Rate (\$)	Cost (\$)
			Task 1	Task 2	Task 3	Task 4			
.....	Principal investigator overall project management	41.6	278	800	348	313	1,739	15.50	26,954
.....	Co-principal investigator	25.0	104	644	174	122	1,044	13.20	13,781
.....	.....	15.6	52	400	113	87	652	11.50	7,498
.....	.....	15.6	70	400	104	78	652	10.75	7,009
.....	.....	12.5	70	383	35	35	523	6.00	3,138
.....	.....	12.5	52	383	52	35	522	6.00	3,132
Totals			626	3,010	826	670	5,132		61,512

* Total Hours ÷ 174 man-hours/month (including leave) ÷ contract months

Figure B-4: NCHRP Requirements for Tabulating Level of Effort in Proposals

Cooperative Features

If assistance in the form of personnel, data, or equipment is required from other agencies, public or private, describe the plans for obtaining such help or information. In the case where such cooperative features play an important part in the conduct of the research, a letter of intent from agencies agreeing to provide cooperative features should be included in the proposal.

Appendices

The appendices may include such things as statements concerning previous work on this problem or related problems, abstracts of related projects. A bibliography or list of references, or descriptive brochures or materials describing the agency’s organization and capabilities in general terms. Any other material not specifically mentioned previously and felt to be relevant for purposes of the proposal may be included as an appendix.

Review of Proposals and Contractor Selection

The selection criteria used by different programs are very consistent, and typically consist of:

1. Understanding of the Problem - Has the investigator grasped what the problem and issues really are and not just reiterated the contents of the request for proposal?
2. Research Approach - Has the investigator stated clearly a research methodology with “whys”, “whats”, “hows”, and “whens” in sufficient detail, in terms of both work and budget, to assess the probability of success and monitor progress against prescribed tasks and milestones?
3. Staffing - Are those who will work on the project identified and their capabilities documented by reference to qualifications, experience and publications? Is the role and responsibility of each contributor clear, and is the contributor available for the time committed in the proposal?

4. Facilities and Equipment - Does the research team have access to all the facilities required to complete the work?
5. Application of Results - Does the proposal provide a realistic appraisal of the prospects for satisfying the objectives? Will the results be reported in a practical manner and is a feasible implementation plan provided?

Forms often provide space for the reviewer to make notes or comments, in addition to entering a score. This is very useful in enabling the reviewer to recall the strengths and weaknesses of individual proposals when they are discussed in committee, sometimes weeks after the review was made. The form used for the initial rating proposal by panel members in the NCHRP is shown in Figure B-5. Weights are assigned by the individual reviewer. In most cases, the greatest importance is attached to the caliber of the research principals and the adequacy of the research approach.

NATIONAL RESEARCH COUNCIL
 TRANSPORTATION RESEARCH BOARD
 1201 Constitution Avenue Washington, D.C. 20418
ANALYSIS SHEET FOR PREFERENCE RATING OF PROPOSALS

PROJECT NO.: _____ DATE: _____
 RESEARCH AGENCY: _____

Other Location
 200 Wisconsin Avenue, N.W.
 Washington, D.C.
 Telephone (202) 336-3701
 Telex (248) NARPC12
 Taurus (202) 336-3889

Comments	Weights	Ratings*	Weighted Ratings
1. Concept of problem	_____	_____	_____
_____	_____	_____	_____
2. Research Approach	_____	_____	_____
_____	_____	_____	_____
3. Application of Results	_____	_____	_____
_____	_____	_____	_____
4. Research principals	_____	_____	_____
_____	_____	_____	_____
5. Facilities and equipment	_____	_____	_____
_____	_____	_____	_____
TOTAL	_____	_____	_____

* Ratings: Outstanding - 5
 Very good - 4
 Good - 3
 Fair - 2
 Poor - 1

Reviewer: _____

NATIONAL RESEARCH COUNCIL 71TH ANNUAL MEETING / JANUARY 22-24, 1993 / WASHINGTON, DC
 The National Research Council is the principal advisory agency of the National Academy of Sciences and the National Academy of Engineering
 in their professional and other capacities.

GUIDE FOR PROPOSAL REVIEW

Cooperative Research Programs (CRP) project panels perform evaluation of proposals in consideration of the selection of agencies for contract negotiation. The Analysis Sheet for Preference Rating of Proposals is provided as a work sheet to assist in the evaluations. Further details of review considerations are provided below. Such considerations as previous performance of research agency as research principals and current work commitments will be reviewed during the panel meeting and agencies. Proposals that do not contain the essential features required by the CRP are returned to the research agencies and are not submitted for panel evaluation.

Evaluation Considerations

1. **Concept of problem** - This is frequently found in the agency's introductory remarks. Something other than a mere duplication or rehashing of the Project Statement is desired as an indication of a good understanding of the problem.
2. **Research approach** - The evaluation of the research approach should consider consistency with objectives described in the Project Statement and the scientific and technical aspects of the research methodology. This should include such items as the approach to data collection, source features, investigative concepts, and reliability of equipment proposed for use. Consideration should be given to whether or not the approach is sufficiently detailed, both in terms of work and budget allocations by cost.
3. **Application of results** - A realistic appraisal of the prospects for successful accomplishment of project objectives is desired. This should consider the statements in the proposal regarding the manner in which the anticipated results would be reported and how they could be used to apply transportation engineering or transportation evaluation practices; e.g., mathematical models, test techniques, field or laboratory test procedures, changes in highway specifications, new methodologies, etc. Particular consideration should be given to whether or not there might be financial or institutional barriers to implementation of useful products from the research.
4. **Research principals** - Proposals are desired only from agencies or individuals having long extensive demonstrated capability from experience in the subject problem area. The rating should be based on the evidence contained in the proposals pertaining to both the extent and the indicated amount of effort by the research principals. Additional information may be presented and evaluated during the panel meeting.
5. **Facilities and equipment** - The survey should be based on the evidence contained in the proposal. It is important to consider whether facilities and equipment are actually available or are ones to be purchased or built. The project budget often provides some insight into the status. Additional information may be presented and evaluated during the panel meeting.

Figure B-5: An Example of a Form for the Initial Rating of Proposals

Research Work Plan

In the absence of specific requirements for the format and content of the research work plan, the following constitutes a useful outline:

- Title
- Introduction
- Objectives
- Research Approach
- Project Team
- Equipment and Facilities
- Budget
- Schedule
- Anticipated Results
- Implementation

The introduction provides background information taken from the Problem Statement or the Request for Proposals. It is included because the work plan should be a “stand-alone” document, i.e. the reader should not need to refer to other documents. The objectives also should be a re-statement of the objectives from the earlier documents. The ‘Research Approach’ is the largest section in the work plan. It should present the hypothesis, and describe and justify the strategy, which is being employed to satisfy the objectives. For instance it could be a desk study comprising literature review and analysis, laboratory studies, field studies, or a combination of approaches. It is usual to divide the work into tasks, each of which constitutes a milestone in the completion of the work. For example, if the study involves writing a state-of-the-art report, the tasks might be:

Task 1	Literature Survey
Task 2	Questionnaire
Task 3	Field Visits
Task 4	Preparation of First Draft
Task 5	Preparation of Second Draft
Task 6	Preparation of Final Draft

For each task the activities should be described in detail. In Task 1 the search strategy and the databases should be described. In Task 2 the recipients of the questionnaire should be identified. If it is known which agencies will be included in the field visits in Task 3, they should be identified, otherwise it should be made clear how the decision would be made. In Task 4, the scope and intended audience should be identified, and a tentative outline of the report provided. The work plan should also state who would review each of the drafts.

In the case of a project that involves experimental work and developing the plans for subsequent fieldwork, the tasks might be as follows:

Task 1	Literature Survey
Task 2	Laboratory Studies
Task 3	Exposure Plot Studies
Task 4	Development of Field Study Design
Task 5	Preparation of Final Report

Task 1 would be described as in the previous example. Task 2 will probably consist of sub-tasks, each comprising a series of experiments. The experiments should be described in detail. This allows the principal investigator to ensure that the necessary people, equipment and laboratory facilities will be available to perform the work, and to calculate the cost of the work. This will usually be an iterative process that involves determining how many experiments can be performed

within the available budget. It is essential that the principal investigator be confident that the experiments being performed will be sufficient to satisfy the objectives for the task. It is also good practice to identify a strategy to be followed if the experimental work is not completely successful, e.g. are there other test procedures that could be used? The work plan should describe clearly what would have been accomplished before Task 3 begins, the way in which the work in Task 3 will be influenced by the results obtained in Task 2, and the manner in which the results will be reported. The activities in Task 3 should be described in the same way as for Task 2, except that they will be more tentative because it is likely that many details cannot be finalized until results from Task 2 become available. Because it is a plan that is being written, it is inevitable that less detail can be provided for the later activities. One of the key roles of the principal investigator is to recognize when changes in the work plan are necessary, and to modify the plan accordingly. The good researcher will maintain flexibility in the work plan to deal with setbacks, and to seize opportunities, while planning in sufficient detail to estimate resources, and to make arrangements for activities which require a long lead time.

In the example given, Task 4 consists of developing a design for a field study to verify the results of Tasks 2 and 3 under real world conditions, not performing the field work itself. The specific details will depend on the results of Tasks 1 to 3, but the plan should contain the following sections:

- hypothesis to be tested on field studies
- criteria for selection of the study site
- potential sites
- equipment and other facilities required
- data collection and analysis procedures
- staffing plan
- schedule
- budget

The final report prepared in Task 5 should provide full documentation of the problem definition, experimental methods, results, conclusions and future activities, including implementation. Further information on the content and preparation of reports is given in Chapter Five.

In the section describing the project team, the team members should be listed, along with the responsibilities and time commitment for each person. This information is required to ensure that each person will be available to work on the project when required, and to establish costs. The key members of the team should be identified, but for junior positions where the work could be done by one of a number of technicians, it is sufficient to identify the person by rank, e.g. senior technician @ 200 hours, 3 junior technicians @ 300 hours each. The key members must be identified because if a substitution becomes necessary, management and the sponsor will need to satisfy themselves that the replacement has the necessary credentials and experience to perform the research. Curriculum vitae are not required in a work plan.

Equipment and facilities are listed for the same reason as personnel, i.e. to ensure that they will be available when needed and that all the costs are captured in the budget. This also forces the researcher to verify that all the equipment necessary to perform the planned experiments is available, or identify equipment and supplies that must be purchased.

If the research approach, project team, and the equipment are documented in sufficient detail, calculation of the budget for the project is relatively straightforward. Other items such as travel, overhead and profit must, of course, also be included.

A detailed schedule for the work is required to establish a completion date and to provide a mechanism for management to measure the progress of the work. It is also needed to identify when resources will be needed, and to calculate cash flow requirements. For projects that involve

no more than about 10 tasks, and about an equal number of sub-tasks, a chart similar to that shown in Figure B-6 is perfectly adequate. Using the second study described above as an example, the chart shows the start and completion dates for each sub-task, and the anticipated progress of each sub-task, as a cumulative percentage. It also shows the interrelationship of the tasks and sub-tasks because it is clear which activities are underway concurrently, and which are sequential. The schedule allows one month for the review of the interim report, and two months to review the final report. The anticipated progress on the overall project can be calculated from a knowledge of the amount of effort required for each task and sub-task. The amount of effort required to complete each sub-task, expressed as a percentage of the effort required to complete the project, is shown in the third column. Taking the end of June 1996 as an example, the anticipated overall completion is:

$$\begin{aligned} & \text{Task 1} + 25\% \text{ of sub-tasks 2a, 2b, and 2c} \\ & = 10\% + 0.25 \times (16\% + 16\% + 16\%) \\ & = 22\% \end{aligned}$$

By plotting the values from the row "Overall Completion" in Figure C-6 against duration of the project, a chart of anticipated progress is developed, as illustrated in Figure B-7. Using the same technique, planned expenditures can be plotted, as shown in Figure B-8, from knowledge of the budget and cash flow projections for each sub-task. Figures C-6 to C-8 are used to measure the progress of the research as described in the section "Execution of the Research".

The Gantt chart provides a powerful visual representation of the work schedule and quite large research projects, typically up to \$1million budget, can be managed in this way. Larger projects, especially those involving many semi-autonomous contributors, or requiring access to expensive equipment that is used on many projects, may require a more sophisticated work schedule to be developed. This can be done by preparing a critical path analysis or using computer software designed for project management.

The final section of the work plan, Implementation, describes how the findings of the research will be implemented. This enables the researchers to involve those who will be responsible for implementation in the research, and to allow the plans for the implementation activities to be developed while the research is in progress so that there is no delay between completion of the research and implementation of the findings.

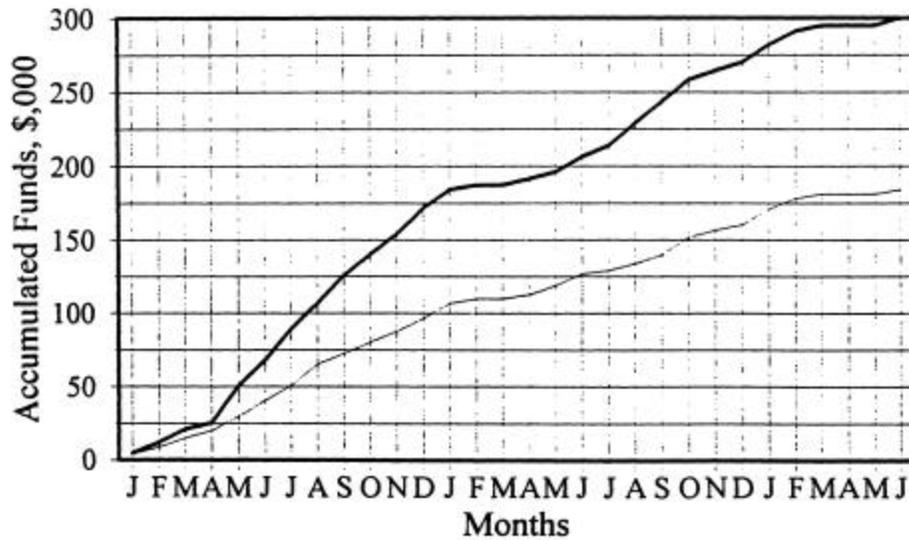


Figure B-8: Anticipated Expenses

Execution of the Research

As noted in Chapter Three, technical progress and financial expenditures must be tracked, and monitored, throughout the period of execution of the research. Charts similar to those illustrated in Figures B-6 to B-8 are suitable for this purpose. As an example, Figures B-9 to B-11 illustrate the status of the project described in the previous section as it might have been reported in December 1996. The data indicate that there were delays in beginning Task 2, but, except for work on the performance tests (Task 2c), the project was back on schedule.

Where a greater level of detail is required, as for example, where different budget codes must be reconciled, comparisons between planned and actual expenditures can be made by category, e.g. salaries, travel, and equipment. In this way, variations can be detected early in the process, and steps taken to bring the project under control.

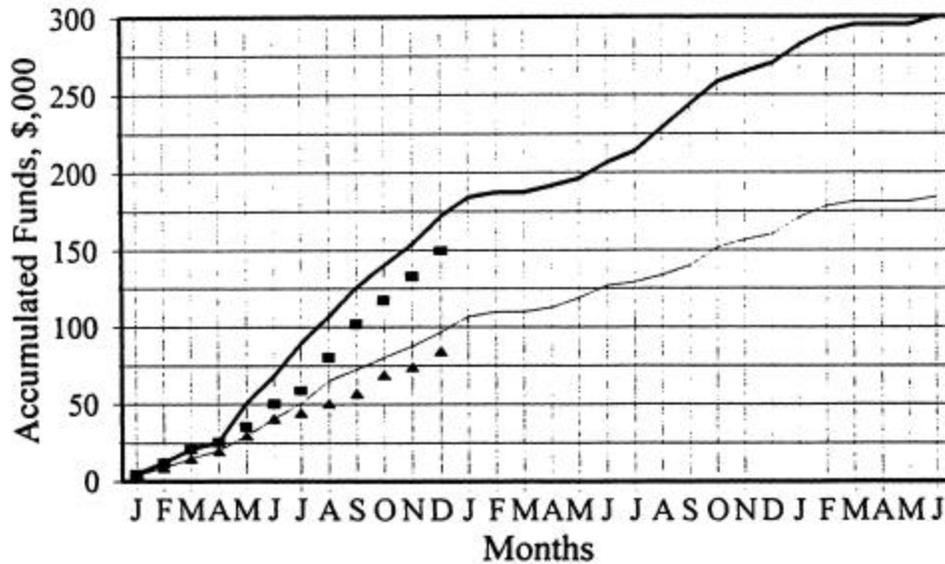


Figure B-11: Expenditures to December, 1996

Implementation and Dissemination of Research Results

An NCHRP study of technology transfer methods and implementation practices included a survey of transportation agencies and an analysis of case studies (10). Much of the information in this section is based on the data collected in the study, and from which the recommendations presented in Chapter Three were developed. Implementation “success” was defined in terms of timeliness, effectiveness, and scope of use. The study examined success from three perspectives:

- Characteristics of the research results
- Characteristics of the implementing organization
- Characteristics of the implementation process

From each perspective, the relative importances of factors that promote implementation, and those which act as barriers to implementation were rated, by participants in a workshop, on a scale of 1 to 5. The results are given in Tables B-1 to B-3 (the data were obtained from figures contained in reference 10). Barriers to implementation have been expressed on a scale of -1 to -5 (-5 being the greatest barrier).

Characteristics of Research Results

Some attributes of the research output can impede implementation. Most obviously, if the research does not meet the needs of potential users, the results will not be put into practice. Also, if users do not see evidence that a new product or process has been adequately tested, they may not want to be guinea pigs.

On the other hand, research results are more likely to be put into practice rapidly and effectively, if the researchers have accounted for real-world situations. In many cases, pilot or demonstration projects are useful steps toward full implementation. Their purpose is to evaluate the new products

or processes under operational conditions, and make any necessary improvements, before full implementation on the in-service system. This is important to reduce the risk of failures. Even when full-scale implementation is adopted, the product or process may be designated experimental for a prescribed period to ensure that there is a systematic evaluation of the how well the changes are working.

Site selection for demonstration projects is much more complex than it might appear to be. The objective is to evaluate the new product or process under conditions, which are representative (with respect to site conditions, difficulty of work, contractor expertise, time of year) of the anticipated future applications while minimizing the risk of delay or failure. Frequently the work must be incorporated in contracts already awarded, or about to be tendered. Each has its disadvantages. Changes to existing contracts are often expensive and the contractor may not have the necessary expertise. Contracts not yet awarded are subject to shifts in award schedules, often resulting in projects being moved from one construction season to another. Rarely will there be an ideal candidate and the selection must be based on compromises between ideal and available conditions. The longer the time available to plan a demonstration project, the greater are the chances of locating site meeting a larger number of the selection criteria.

Positive Factors	Rating	Barriers	Rating
Pilot projects in real settings	4.2	Mismatch between research and user needs	-4.3
Implementation package with research output	4.0	Research output not sufficiently tested	-3.8
Research adaptable to varied contexts	3.3	Research output does not fit work procedures	-3.6
Research designed for commercialization	2.5	Allocation of patents etc. not settled	-3.1

Table B-1: Factors Pertaining to the Characteristics of Research Results

Positive Factors	Rating	Barriers	Rating
Management commitment	4.8	Risk aversion	-4.2
Long-term innovation champions	4.1	Organizational inertia	-4.2
Capability to sustain innovation	4.0	Inflexible contract specifications	-3.9
Incentives for change	4.0	Discomfort with change	-3.9
In-house expertise	3.9	Legal liability	-3.8
On-the-job recognition	3.7	Inadequate resources	-3.8
Performance-oriented specifications	3.4	Skill obsolescence	-3.2
Job rotation assigned	2.7	Political involvement with managers	-3.2
		No local precedents	-2.8
		Inadequate travel budget	-2.6

Table B-2: Factors Pertaining to the Organization

Positive Factors	Rating	Barriers	Rating
Researcher-user pilot collaboration	4.6	User successes unpublicized	-3.7
Users help design research	4.4	Poor quality/relevance filters	-3.6
Targeted funding	3.6	One-way dissemination	-3.6
Easy access to researchers	3.4	Costliness	-3.6
Effective training	3.2	Unknown information source	-3.2
Mandatory innovation use	2.5	Researchers not market-oriented	-2.5

Table B-3: Factors Pertaining to the Implementation Process

Characteristics of the Organization

The most important institutional barriers to implementation include organizational inertia, risk-averse behavior, management discomfort with change, and inadequacy of resources. As noted in the section describing the characteristics of research results, new products and processes entail a degree of risk. Some will prove not worth their cost, and some may not function effectively. The organization must be prepared to encourage staff to innovate, and to support them even when new ventures are not successful. This includes a commitment on the part of senior management to provide resources for implementation efforts and the willingness of senior officials to champion innovation.

Characteristics of the Implementation Process

Collaboration between the researchers and the users throughout the research and implementation phases is the key to the successful use of research results. Many agencies involve the researchers, in-house or contract staff, in the implementation efforts and technology transfer. Commonly, this involves giving seminars or training sessions to agency staff. Depending upon the circumstances, it could also involve evaluating the success of demonstration projects or results designated experimental. However, some agencies deliberately limit the involvement of researchers in the implementation process. The main reasons for doing so are that the contractor is not familiar with the internal process of the agency, and not necessarily expert in implementation efforts. It is also recognized that the implementation effort is substantial, and often different disciplines from those needed to conduct the research. In cases where the researchers are not involved directly in the implementation efforts, it is important that they be accessible.

Cost is frequently a major impediment in implementing new products, and procurement rules that prohibit sole-sourcing can be a major obstacle. Targeted funding for implementation, and flexibility to incorporate experimental features in construction contracts are effective ways of dealing with these problems.

Evaluation of Research Projects

This section describes the tools that are available for use in the evaluation of research projects. Most of the information is taken from reference 11.

Expert Opinion

This method involves obtaining the opinions of people who are knowledgeable about the subject of the research and the impact of the project being evaluated. The experts can be internal or external to the agency.

Expert opinion is often solicited in the project selection phase. The opinion can be provided on an unstructured basis, or structures using performance indicators such as the quality of the research, level of innovation, or economic impact.

User or Client Opinion

This method involves obtaining the opinions of clients, often through technical advisory committees or project panels. Like expert opinion, client opinion is most commonly sought when problem statements or proposals for research projects are reviewed. Surveys are a useful method of obtaining client or user input in situations where there are numerous users, or the users are widely separated geographically.

Cost-Benefit Methods

Cost-benefit analysis seeks to assess the project in terms of the economic and social benefits generated for a particular “referent group” (e.g. an agency, a region or society as a whole) as well as the economic and social costs incurred by the referent group to carry out the research and implement the results. The definition of the referent group is important because it defines the bounds for the analysis. There are a number of general principles associated with conducting cost-benefit analyses of transportation-related research projects.

- There are three main types of costs associated with a research project that must be taken into account in the analysis. These are the costs of generating the research results, the costs of introducing and supplying the results to the end users, and the costs incurred by the end users to implement the results.
- The benefits of the research project are valued at the price society is willing to pay for them. The assessment of benefits includes not only those for which prices are paid, but also benefits associated with, for example, reduced environmental damage, better air quality and improvements in health and safety, even though such benefits may be difficult to quantify.
- Once they have been identified, all the benefits and costs associated with the project are compared using a common measuring system of constant dollar values. Allowances can be made for future changes in relative real prices, but no adjustments are made for the future changes in the general price level as a result of inflation or deflation. All costs and benefits must be discounted to their present values through a social discount rate before they can be compared to determine the net benefit of the project to society. The selection of the discount rate is controversial, and has a major impact on the results of the analysis. The discount rate is intended to be the social discount rate, which represents the present generation’s weighting of benefits and costs to be borne by future generations. In the private sector, the discount rate is sometimes taken to be the difference between the prime interest rate and the rate of inflation.

The net present value is given by the formula:

$$NPV = \sum_{i=1}^N \frac{(Bi - Ci)}{(1+r)^i}$$

where Bi = the benefits attributable to the project in year i

Ci = the costs attributable to the project in year i

r = the discount rate

N = the number of years over which benefits and costs (compared to the “base case”) can be estimated, usually 5 to 10 years.

- The research project being analyzed must be incremental, and the benefits must be attributable to the results of the research. “Incremental” means that the results would not have been available in the absence of the project. “Attribution” deals with the extent to which the benefits are actually due to the research results. This is extremely important in defining the “base case” which is rarely the situation before the project was undertaken, but more properly it reflects benefits that would have occurred even if the project had not been undertaken. This includes the incorporation of developments made elsewhere, and changes that would have occurred from sound management strategies. Given the uncertainty of research, many evaluators find cost-benefit analysis impractical, except possibly for projects which have been completed for some time, and which have well-defined benefits. On the other hand, cost-benefit analysis can be a useful method for deciding which potential projects are most attractive, and for demonstrating the value of investing in research.

Further guidance and examples of the application of cost-benefit analysis to research projects are given in reference 11.

Case Studies

Case studies involve a detailed and thorough analysis of research projects, and seek to track and document the evolution of the impacts associated with the research. The advantage of case studies is that they afford the best opportunity of identifying the relationship between the research study and the impact of the research results. They are particularly useful for evaluating projects that benefit the public good, rather than using cost-benefit analyses that assign dubious values to some impacts such as the value of a human life. Because the results are usually qualitative, it is difficult to use case studies to compare the value of projects, or to aggregate the results to demonstrate the value of research programs.

Performance Indicators

There are two main categories of performance indicator methods, partial indicators and integrated partial indicators. The first method involves the collection of information items, each of which provides some insight into the project such as cost, time, risk and potential outputs. The method of integrated partial indicators involves the collection of the same kinds of information, except that it is integrated in some way. The method usually involves summing the partial indicators to arrive at a “bottom line score”. The most common approach is to evaluate each project with reference to a specific set of criteria (e.g. cost, feasibility or risk, likely impact, relevance to the agency mandate), assign a score and a weight to arrive at an overall score for the project. This method is often used to select individual projects, and to evaluate responses to requests for proposals.

