

National Cooperative Transit Research & Development Program

PROGRESS REPORT 11

FOR THE PERIOD
JULY 1 THROUGH DECEMBER 31, 1986
CONTRACTS DTUM60-81-C-72012
and DTUM60-83-C-71226

PRIVILEGED DOCUMENT

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NATIONAL COOPERATIVE TRANSIT RESEARCH & DEVELOPMENT PROGRAM

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National Cooperative Transit Research & Development Program

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PROGRESS REPORT 11

FOR THE PERIOD JULY 1 THROUGH DECEMBER 31, 1986

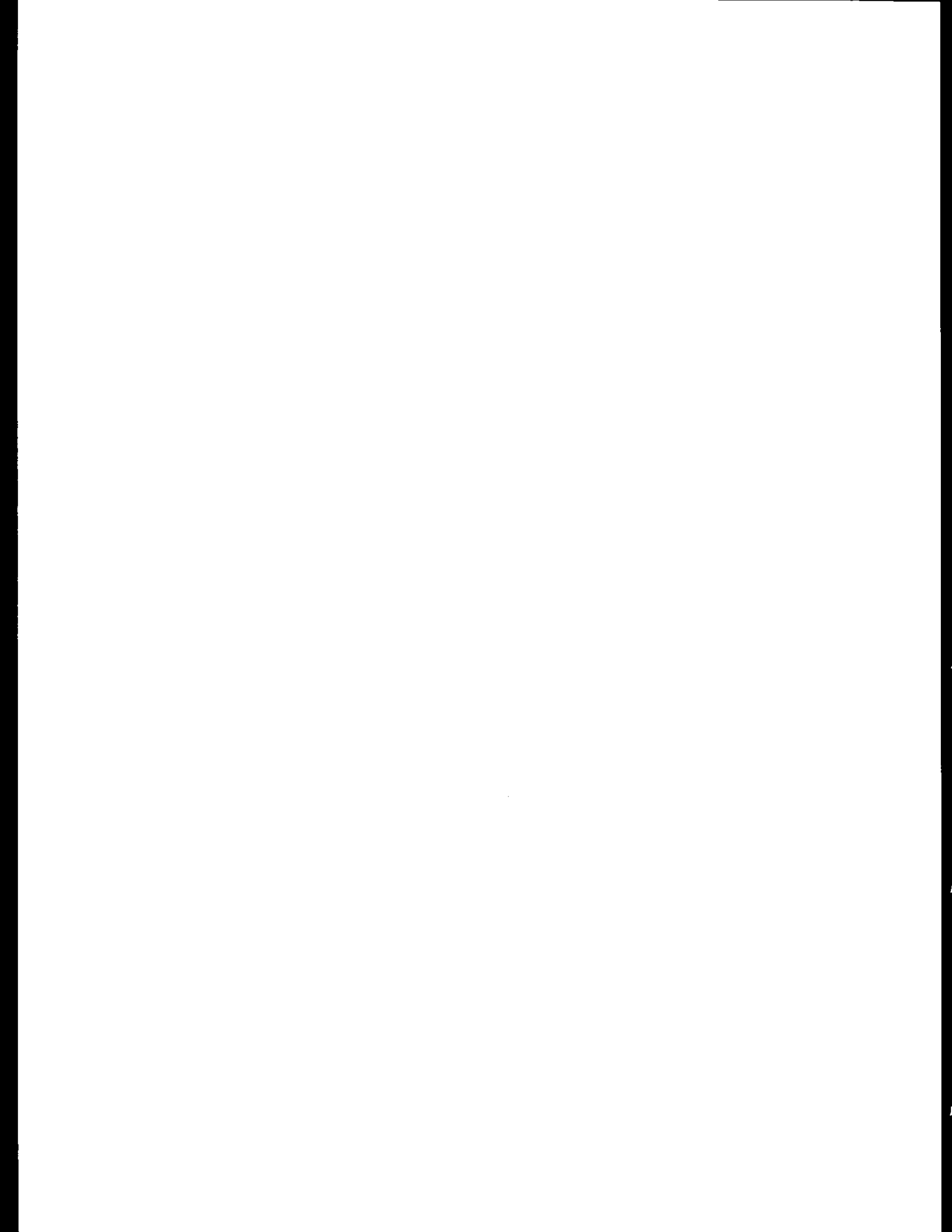
TO THE U.S. DEPARTMENT OF TRANSPORTATION/URBAN MASS TRANSPORTATION ADMINISTRATION
(DOT CONTRACTS DTUM60-81-C-72012 and DTUM60-83-C-71226)

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FOREWORD

This document responds to Article II, Deliverable Items and Delivery Schedule, of DOT Contracts DTUM60-81-C-72012 and DTUM60-83-C-71226 between the U.S. Department of Transportation/Urban Mass Transportation Administration and the National Academy of Sciences, National Research Council, designated the Primary Technical Contractor(PTC), for technical and administrative services relative to the Urban Mass Transportation Administration's National Cooperative Transit Research & Development Program(NCTRP). Distribution of this document is made only to the sponsors and others participating officially in the conduct of the NCTRP.

Annual NCTRP activity consists of five (5) distinct phases: (1) Problem Identification, (2) Program Formulation, (3) Project Formulation, (4) Project Execution, and (5) Project Reporting. The PTC's obligation is relative to Phases 2 through 5, and responsibilities for administration of technical matters under these phases have been assigned to the Transportation Research Board, a major unit of the National Research Council. The TRB consists of four(4) divisions with Division D, Cooperative Research Programs, being the one to which NCTRP administration is assigned.

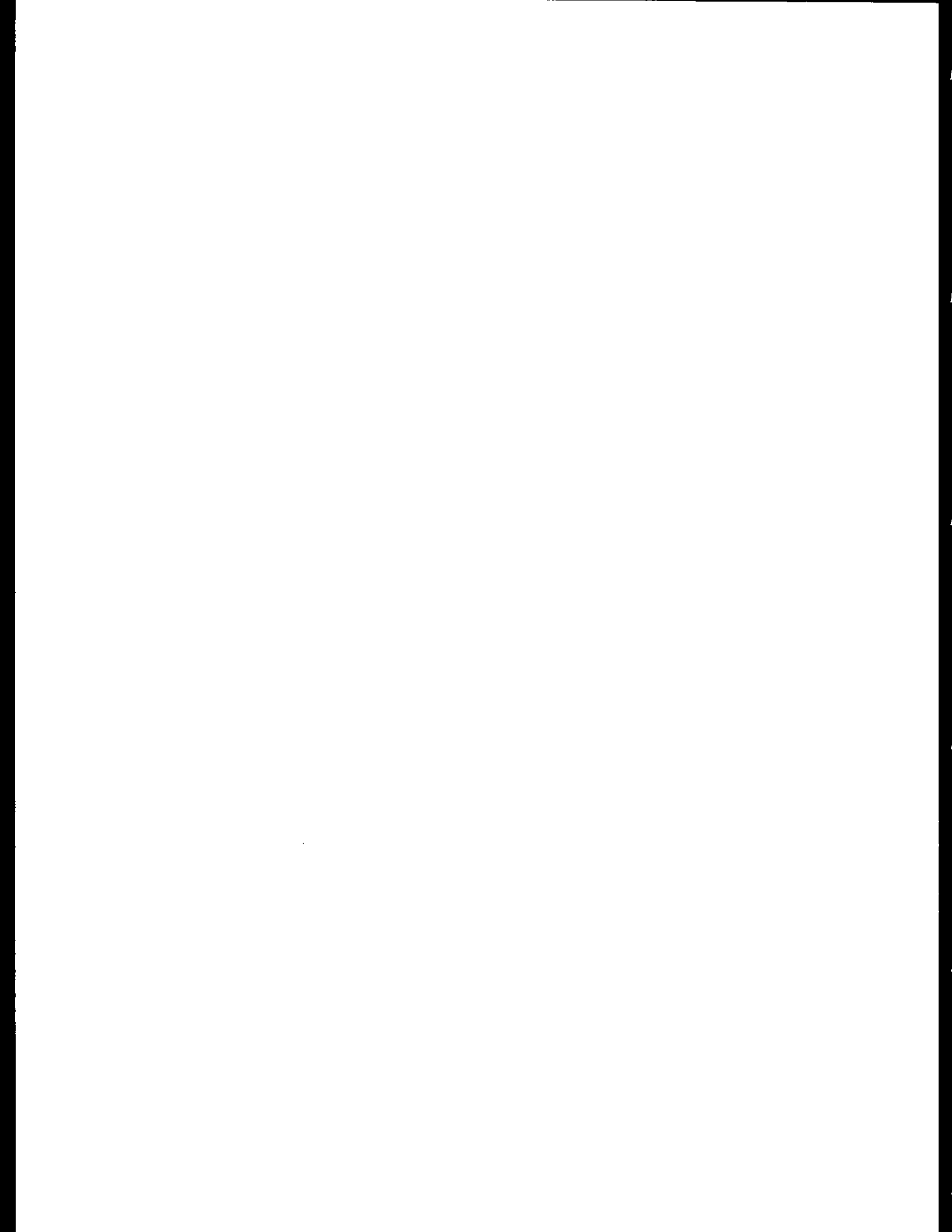
Research programs are referred annually by UMTA to the PTC for administration, and semi-annual progress reporting includes: (1) general coverage of the historical development of the NCTRP and the means by which the Program is carried forward, (2) elaboration on the management practices exercised by the TRB in behalf of the PTC and UMTA, (3) summarization of management activities and deliverables in the six months reported, and (4) provision of detailed reports on each project under contract during the report period as to the: (a) general research need, (b) specific research objectives, (c) progress in achieving project objectives, (d) availability of any reports emanating from the study, and (e) prognosis for ultimate success. Each project report includes identification of the TRB staff engineer having surveillance responsibility and with whom contact may be made for additional insight concerning any details of the contractor's work. Opinions and/or conclusions conveyed by the project reports are those of the research agencies and do not necessarily reflect the position of the Transportation Research Board, the National Research Council, or the Urban Mass Transportation Administration, U.S. Department of Transportation, and no official endorsement should be inferred.

A detailed overview of all aspects of NCTRP operation may be obtained from the following:

- NCTRP Annual Summary of Progress
- NCTRP Information and Instructions for Preparing Proposals

These are available from the Transportation Research Board on request through:

Cooperative Research Programs
Transportation Research Board
2101 Constitution Avenue, N.W.
Washington, D.C. 20418
(202) 334-3224



NATIONAL COOPERATIVE TRANSIT RESEARCH & DEVELOPMENT PROGRAM

INTRODUCTION

Administrators, engineers, and many others in the transit industry are faced with a multitude of complex problems that range between local, regional, and national in their prevalence. How they might be solved is open to a variety of approaches; however, it is an established fact that a highly effective approach to problems of widespread commonality is one in which operating agencies join cooperatively to support, both in financial and other participatory respects, systematic research that is well designed, practically oriented, and carried out by highly competent researchers. As problems grow rapidly in number and escalate in complexity, the value of an orderly, high-quality cooperative endeavor likewise escalates.

Recognizing this in light of the many needs of the transit industry at large, the Urban Mass Transportation Administration, U.S. Department of Transportation, got under way in 1980 the National Cooperative Transit Research and Development Program (NCTRP). This is an objective national program that provides a mechanism by which UMTA's principal client groups across the nation can join cooperatively in an attempt to solve near-term public transportation problems through applied research, development, test, and evaluation. Particularly noteworthy is the fact that the client groups now have a channel through which they can directly influence a portion of UMTA's annual activities in transit technology development and deployment. Although present funding of the NCTRP is entirely from UMTA's Section 6 funds, the planning leading to inception of the Program envisioned that UMTA's client groups would join ultimately in providing additional support, thereby enabling the Program to address a larger number of problems each year.

The NCTRP operates by means of agreements between UMTA as the sponsor and (1) the National Academy of Sciences (NAS), a private, nonprofit institution, as the Primary Technical Contractor (PTC) responsible for administrative and technical services, and (2) the American Public Transit Association responsible for operation of a Technical Steering Group (TSG) comprised of representatives of transit operators, local government officials, State DOT officials, and officials from UMTA's Office of Technical Assistance.

Annual NCTRP activity consists of five (5) distinct phases: (1) Problem Identification, (2) Program Formu-

lation, (3) Project Formulation, (4) Project Execution, and (5) Project Reporting. The PTC's role is relative to Phases 2 through 5.

Research programs for the NCTRP are developed annually by the Technical Steering Group, which identifies key problems, ranks them in order of priority, and establishes programs of projects for UMTA approval. Once approved, they are referred to the PTC for administration through the Transportation Research Board (TRB).

The Board, established in 1920, is a unit of the National Research Council, which serves as the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering, and is uniquely suited for the administrative role because: it has a record of successful management of the National Cooperative Highway Research Program (NCHRP) since 1962, the program after which the NCTRP has been modeled; it maintains an extensive committee structure from which authorities on any transportation subject may be drawn; it possesses the avenues of communications and cooperation with federal, state, and local government agencies, universities, and industry; it is recognized for its objectivity and understanding of modern research practices; its relationship to the National Research Council is an insurance of objectivity, and it maintains a full-time staff of research specialists in transportation matters to take the findings of research directly to those who are in a position to use them.

Research projects addressing the problems annually referred from UMTA are defined by panels of experts established by the TRB to provide technical guidance and counsel in the problem areas. The projects are advertised widely for proposals, and qualified agencies are selected on the basis of research plans offering the greatest probabilities of success. The research is carried out by these agencies under contract to the PTC, and administration and surveillance of the contract work are the responsibilities of the PTC and the Board.

The needs for transit research are many, and the National Cooperative Transit Research and Development Program is a mechanism for deriving timely solutions for transportation problems of mutual concern to many responsible groups. In doing so, the Program operates complementary to, rather than as a substitute for or duplicate of, other transit research programs.

MANAGEMENT PRACTICES IN THE NCTRP

The commentary that follows is to provide insight into the Academy's functions directed to TRB's management of UMTA's resource allocation for NCTRP research under Contracts DTUM60-81-C-72012 and DTUM 60-83-C-71226. Highlighted are those activities in which all possible opportunity is taken to weight the odds in favor of obtaining implementable solutions to near-term public transportation problems. A more detailed overview of all aspects of Program operation may be obtained from the following:

- NCTRP Annual Summary of Progress
- NCTRP Information and Instructions for Preparing Proposals

Organizationally, the TRB consists of four divisions, each headed by an assistant director reporting to an executive director, who in turn reports to an executive committee. Division D, renamed in 1979 as *Cooperative Research Programs*, was established in 1962 as a special-purpose activity to administer contracts for research under the NCHRP, and it now encompasses the NCTRP. Division D's activities are thus distinctly different from the Board's traditional role of information gathering and dissemination on behalf of a variety of sponsors. Among the differences in operation is the fact that the funds supporting Division D are obtained through channels outside those pertaining to the Board's other divisions; they are budgeted separately; they are accounted for separately; and they are audited independently of those for the Board's other activities. Furthermore, the funds can be spent only on the research designated by the sponsors of the programs administered under Division D.

It should also be recognized that the overall policies and procedures, including the formulation of annual research programs, are entirely the responsibilities and prerogatives of the sponsors. Neither the regular committees nor the Board's staff have a role in the submission or selection of research problems.

UMTA's goal for the NCTRP is a program within which its resources will be managed well and appropriately directed in the search for solutions to near-term public transportation problems. Applied, or mission-oriented, research is a means to the end as regards the technological approach.

The findings from basic research completed elsewhere are brought into play to bring about new technologies. The expectation from the sponsor is that the resource allocation will result in the development of technology that, when implemented, will make life a little easier—not merely the development of scientific knowledge that has no direct practical application. Meeting this expectation is somewhat comparable to new-product research in industry, and, in addition to being extremely costly, the probability of failure is high. Furthermore, although projects may begin as applied research, the synergistic nature of research often catapults them back into the realm of basic studies, because true solutions are not achieved without understanding the underlying causes for the problem so that they may be accounted for in the future.

Although each year's funding base is targeted at about \$1 million, which represents about one-fourth the amount contemplated in the planning processes leading to establishment of the NCTRP, the actual amounts being made available are falling short of the target. Consequently, an urgent need exists for supplementary support from UMTA's client groups joined in a cooperative venture. In any event, proper management of resources is the sole basis for establishment of the Board's entire philosophy, organization, and functions regarding work under Division D. Toward this end, network control is employed in the classic sense of network utilization for project management. Primary focus is on those milestones where the best opportunities lie for positively weighting the odds of success. These opportunities are afforded through the use of common-sense strategies to control various circumstances surrounding each milestone. Processes result that will, through the natural evolution of interdependent events, increase the probability of research results being implemented and improving transportation practices. Such an approach is complex and must be monitored constantly. Nonetheless, its practical application cannot be neglected if, in the context of total administrative responsibility, one wants to take advantage of all possible opportunities to ensure the best return on the sponsor's investment.

As a first element of strategy, the NCTRP establishes the research agency and personnel qualifications that are mandatory if the projects are to have any chance of success. These are spelled out to potential proposers and are adhered to in selecting research agencies. By means of the project statements and various other widely distributed publications, the NCTRP clearly states the agency attributes deemed essential and thereby hopefully precludes proposals from any but qualified researchers having practical experience in the problem area. Emphasis is placed on the importance of a record of successful past performance in endeavors similar to those to be undertaken. The specifications for proposals are demanding in the sense of requiring the agencies to lay their knowledge, experience and accomplishments on the line, and proposals simply are not accepted if, among other factors, they do not contain specific statements as to how the contemplated results can be used to improve practice.

The next element of strategy comes into play when a research problem and its objectives are first defined in the form of an NCTRP Project Statement by which research proposals will be solicited. A continuing responsibility of the Board is to see that the projects are sensibly structured around the practical facts of operational life and that they represent current circumstances. Therefore, this task is carried out by persons not only very knowledgeable in the problem area but who also have a complete understanding of the needs of the practitioners with whom the problem originated and the best format by which the practitioner can utilize the results. Improved odds therefore become immediately inherent.

Toward the goal of sensible projects, the Board has established seven broad research fields under which project panels are organized to deal with research in specific

NCTRP RESEARCH FIELDS AND AREAS

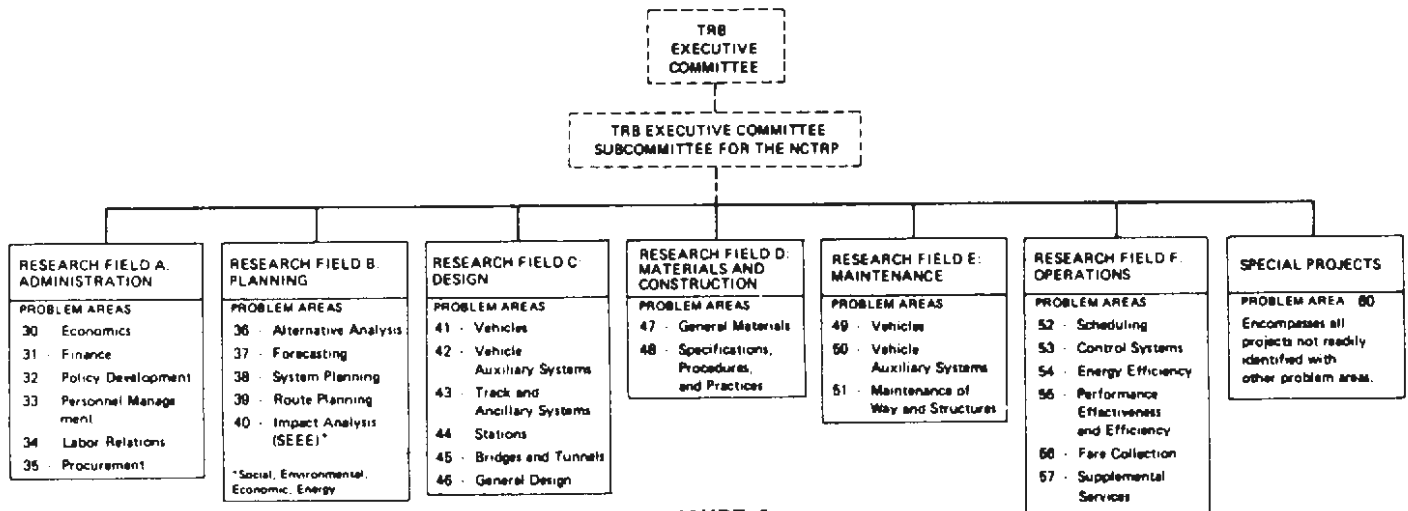


FIGURE 1

problem areas falling within the broad fields (refer to Figure 1). For example, in the broad subject field of Operations each project falling within the more specific subject areas of Energy Efficiency—Area 54—is assigned a project panel comprised of outstanding individuals who are very knowledgeable in the specifics of the particular project and who are looked to for guidance and counsel throughout the research and reporting phases. Those projects that do not conveniently fit under one of the first six general fields are assigned to the seventh one, Special Projects.

Each project is assigned a panel consisting of outstanding individuals very knowledgeable in the project area and who are looked to for technical guidance and counsel throughout the research and reporting phases. A search is made far and wide for these individuals, and the Board usually receives about four to five times as many nominees as can be used in the available panel positions. Panels are appointed by the National Research Council for the life of their projects and, with the coming and going of projects, usually involve some 200 people at any one time. All members serve without compensation, and their total yearly contribution to the Program runs to thousands of man-days. The panel members are drawn from all walks of professional life, and heavy dependence is placed on the sponsor for providing members. Their perspective, in defining the research needed for operational problems, is most important if projects that are both practical and "doable" within the limits of available funds are to be structured.

When the project panels meet for the first time to prepare project statements, it is stressed to them that a first-class statement is the first of the two most important factors bearing on the ultimate success of any project. Accordingly, extreme care is exercised in the development of clear, concise project statements that are distributed to the research community at large. These statements contain objectives designed to result in the most extensive work possible for the available funding. They spell out what is expected of a contractor in terms of findings from

innovative research that can be applied practically; they do not spell out how to go about the research. Statements of explicit objectives, matched to funding, places proposers in the position of knowing exactly what is expected of them, because the available funding is made known along with the objectives. Not only does this result in more realistic proposals, but it most assuredly eases each project panel's task of comparative evaluation. Of the members of the NCTRP's project panels to date, about 34 percent come from transit operating agencies. Because of their intimate involvement in the development of the various research projects, their knowledge of what is to be expected, and the "spreading of the word" among their associates, there is yet another step toward improving the odds that results will be put to use.

The second of the two most important factors, and the next element of strategy, concerns the process of evaluating proposals to select research agencies. The odds can be advanced materially if extreme care is exercised throughout this activity. Indeed, this activity constitutes the milestone on which the success of the project can become totally dependent, irrespective of the strengths built in at the preceding milestones. Prior to contracting, there *must* be satisfaction not only that the proposed research plan is the best possible in addressing the specifics of the objectives, but also that it culminates with the best promise for providing transit agencies with a product that is both usable and readily implementable; otherwise, the proposal process—and possibly that of project definition—should be repeated. The importance of this activity is made abundantly clear to the project panels when they meet to select agencies and suggest minor modifications of the research plans as a means for keeping them squarely on target. A comprehensively detailed research plan not only aids the selection process but also serves as the yardstick by which the staff exercises day-to-day surveillance of research progress.

Two top proposals are chosen for each project. The deliberations of the project panel include a review of all known aspects of agency performance on other research

projects under NCTRP or elsewhere and a determination that the first-choice research plan offers the best promise for providing a product that is both usable and readily implementable. A key factor is the merit of the research approach and the experiment design. There is nothing anywhere in the Program's specifications that says the project statements must be adhered to strictly in every detail and that any deviation in research thrust or from the proposed project period warrants outright rejection. The key element is that the agencies must present a strong, convincing case for whatever approaches they take. These always receive just consideration because the sole interest of the project panels is to determine the plan with the best probability of success.

Prior to contracting, any suggested modifications are taken by the Program staff to the agencies, and a clear meeting of the minds is established regarding what is specifically expected from the research and the personnel carrying it out. By means of the "Procedural Manual for Agencies Conducting Research in the National Cooperative Transit Research and Development Program," further emphasis is placed on the requirement for practically oriented research and the proper means for reporting it. Experience has demonstrated that, once the research is under way, the practical fact of life is that the destiny of the research is pretty well committed, no matter how extensive the staff surveillance or how many administrative processes are available to accommodate changes. Rarely are changes accompanied by gains when having to stay within the original funding; rather, the effects are usually negative.

A first requirement of the research agency immediately after subcontracting is the development of a working plan that is intended to be a comprehensively detailed amplification of the approved research plan, inclusive of a specific schedule of events for the major tasks. This document is used by the staff in the day-to-day surveillance of the project's progress. Should review of this document by the staff and project panel bring to light necessary changes that were not previously apparent, these can be accommodated without hindering prosecution of the work. Through this activity, an additional opportunity is afforded for improvement of the odds of success.

As a means of mutual assistance while work is under way, two types of progress reports are required from the agencies. On a monthly basis, one-page progress schedules are submitted that graphically depict several aspects of progress. On a calendar quarter basis, narratives are required that fully describe accomplishments to date and outline future activities based on the accomplishments. Based on these reports and information gained through surveillance visits, Program staff prepares its own progress reports that are sent to UMTA and the Technical Steering Group as a measure of providing a current awareness of on-going work. By these controls the Program is, to some degree, able to appraise the agency's level of performance, while at the same time the agency is provided with tools to assist its own management responsibility in both administrative and technical respects. All too often in the administration of research programs problems arise because there is insufficient communication between the

agency's management staff and the technical staff performing the research.

Project surveillance constitutes a major element of strategy in achieving the administrative goal. The gains here reflect the effort that the NCTRP staff exerts (a) to keep the research in line with the approved research plan; (b) to keep the researchers continually aware of the needs of the practicing engineer; and (c) to see that all project developments, through final reporting, center around these practical needs. Projects engineers with wide-ranging experience are assigned to the NCTRP by the Board and are responsible for administrative and technical surveillance of the contracts. Their activities include visiting each research agency at least once every six months to discuss the status of the work with the principal investigator(s) and to determine if the research is being pursued in line with the approved research plan. Any need for change in the plan is referred to the project's panel for review and approval. Finally, the staff engineer and the project panel evaluate the final report on the completed research to determine the degree of technical compliance with the subcontract and to ensure adherence to the Program's specifications for report writing.

Research agencies are required to report their results in language that is understandable and succinctly summarizes the results so that the transit administrator and others may easily determine their usefulness to their operations. The objectives are accomplished through a "Summary of Findings" and a chapter on "Interpretation, Appraisal, and Application of Results." The detailed research techniques and analyses in which a researcher would be interested are presented as report appendices. Available to the researchers in report preparation are guidelines that have been developed with the objective of providing a report of maximum utility to the transit industry. Each report, as finally published in the regular NCTRP series (Reports or Syntheses of Transit Practice) also contains a staff-prepared foreword that directs the attention of the busy reader to the persons who would be most interested in the results and, also, to how the results fit into present knowledge and practice.

All reports are reviewed by the project's panel to determine if the report indicates reasonable accomplishment of the technical aspects of the research plan; if the conclusions are adequately supported; if the clarity of presentation is satisfactory; and if the report is free from statements on sensitive matters. If the report qualifies for publication at this point, it is further reviewed by the Committee on NRC Oversight (CNO) when a question of sensitivity is involved. Outside reviewers, i.e., reviewers having no responsibility in the conduct of the research, may be asked to review a report at any stage either for the benefit of their technical expertise or for opinions relating to broader issues underlying the report including public sensitivity.

Prior to publication, extraordinary measures are taken to ensure that useful research results are made immediately available to the appropriate personnel. One means consists of forwarding copies of the research agency drafts of final reports. According to the urgency of the particular circumstances, these drafts may be either uncorrected or

corrected on the basis of an acceptance review. Several copies of unedited drafts of the agency reports are retained until formal publication and are available, on a loan basis, to others having an interest in the research. Once published in their entirety, the drafts are destroyed.

After publication, each report is distributed widely through the TRB's selective distribution system. Copies go automatically to about 100 libraries, TRB transit representatives, educational institution liaison representatives, appropriate project panels and committees of the Board, and individual members who have selected publications in the particular subject area of the report. As a further means of disseminating the research reports, announcements of their availability are made to the trade press. Also, the Technical Activities Staff comprising the Board's Division A follow the progress of the work throughout its conduct and consequently are able to discuss application of the research results with potential users during visits to operating agencies.

A tragic result of much research is a compilation of findings that, because of language and form, simply cannot be used until the sponsor devotes considerable supplementary effort to translating the findings into the language and working tools of the users. This kind of time cannot be afforded in the sponsor's scheme of day-to-day operation. In an applied research program such as the NCTRP, the sponsor rightfully expects a product that has immediate applicability to practice. This is not asking too much, because improvements are going to occur mostly in the form of incremental refinements of existing practices, rather than as dramatic innovations or breakthroughs that one might expect from extensive basic research. Therefore, where necessary as an integral part of administration, staff assumes the role of interpreter and interjects itself as a third party between the sponsor and the researcher by means of a very brief publication titled *NCTRP Research Results Digest*. The Digests are issued as a series of flyers to provide in understandable language an early awareness of project results so as to encourage early implementation. They are brief in summarizing specific findings—they do not deal with methodology—and require the reader to expend very little time in determining the usefulness of the findings. Reference is made in each to the fact that uncorrected draft copies of the agency's report are available on a loan basis for those desiring more extensive information. Where circumstances warrant, staff does not wait for requests for reports but distributes copies of the agencies' draft final reports to appropriate personnel.

With the culmination of the formal reporting activity, plus any of the special measures just described, the NCTRP reaches the final milestone of its administrative network. What happens beyond that point—how successful the projects really turn out to be—is entirely up to UMTA and the operating agencies. Projects that have accomplished their objectives in providing useful products might just as well have been failures if, at least, consideration is not given to how the results might be used to improve operations. It simply does not make good sense to invest millions in research on critical problems and then not give adequate attention to a determination of

the implementation value of the products. Such determination can range from mere thought to total, immediate incorporation as standard practice. Certainly, any action must be temperate to avoid the pitfalls that are present in pushing too hard too fast. To aid decisions as to the course to be pursued, future NCTRP publications will report on all known uses of results, be they limited or extensive. Given the fact that the NCTRP addresses critical, national problems, documented payoff to any one agency should attract study by others. So should documented failures, for they also contain lessons by which all can profit. Research is a venture into risk and uncertainty, the risk being particularly high in applied or mission-oriented research such as the NCTRP undertakes. The wisdom of accepting risk is impossible to determine without studious inquiry into the benefits derived.

In summary, the NCTRP is an applied, contract research program that has been structured along specific lines to enable it to respond to specific needs of the nation's transit industry. The needs are expressed through problem statements referred from UMTA, and each problem is accompanied by the funds to see it through. From the preparation of project statements through final reporting on the projects results, the goal of the NCTRP is administration that, in the final analysis, will prove to be fully effective in obtaining the best return on the investment supporting the Program.

SUMMARY OF ADMINISTRATIVE PROGRESS

With respect to the TRB role in overall NCTRP operation, the Board (1) administers the annual program under which the Academy has contracted with various classes of agencies for research services, (2) administers the annual program next in line and referred by UMTA for contracting, and (3) provides technical support services for the Technical Steering Group (TSG) and/directed to the development of research programs under all years. The following summary addresses the research programs for fiscal years 1980 through 1986, and it pertains to specific activities occurring between July 1 and December 31, 1985.

FY 1980 Program

This program was initiated in November 1980 and was funded at \$1,040,000 to support eight projects, two of which were designated for syntheses by TRB. All research has been completed. Two syntheses, two *NCTRP Research Results Digests*, and four regular series reports have been published and delivered to UMTA. The final report on Project 47-1 is expected to be published in early 1987. A brief summary of the status of these projects is:

- 31-1 Completed—Published as NCTRP Report 2
- 33-1 Completed—Unpublished (see report availability in Progress by Project Section.
- 36-1 Completed—Published as NCTRP Report 4; FY '84 continuation is underway.
- 47-1 Completed—Report to be published NCTRP Report 14.

TABLE I
SUMMARY OF STATUS THROUGH JUNE 30, 1986, FOR FY '80 THROUGH FY '84 PROJECTS

PROJECT		RESEARCH AGENCY	SUBCONTRACT AMOUNT OR SUBCONTRACT COST (\$)
NO.	TITLE		
AREA 30: ADMINISTRATION—ECONOMICS			
30-1	Small Transit Buses: A Manual for Improved Purchasing, Use, and Maintenance	Arthur D. Little	\$299,378
AREA 31: ADMINISTRATION—FINANCE			
31-1	The Impacts of Federal Grant Requirements on Transit Agencies	Booz-Allen	49,522 *
31-2	Transit Capital Investment to Reduce Operating Deficits: Alternative Bus Replacement Strategies	Fleet Maintenance	150,000
AREA 33: ADMINISTRATION—PERSONNEL MANAGEMENT			
33-1	Transit Bus Operator Selection and Training for Dealing with Stress	GAMS Inc.	150,000 *
33-2	Assessment of Job Enrichment Programs for the Transit Industry	Public Admin. Service	97,821 *
33-2(2)	Quality-of-Work-Life Programs for the Transit Industry—Regional Seminars	Public Admin. Service	52,454
33-3	Public Transit Bus Maintenance Manpower Planning	Fleet Maintenance	100,000 *
AREA 36: PLANNING—ALTERNATIVE ANALYSIS			
36-1	Improving Decision-Making for Major Urban Transit Investments	System Des. Concepts	200,000 *
36-1(2)	Assessment of Current Planning Practice for Major Transit Investments	Sydec, Inc.	30,000
AREA 38: PLANNING—SYSTEM PLANNING			
38-1	National Transit Computer Software Directory	COMSIS Corp.	98,457 *
38-1(2)	National Transit Computer Software Directory—Phase II	COMSIS Corp.	50,000
AREA 39: PLANNING—ROUTE PLANNING			
39-1	A Modular Approach to On-Board, Automatic Data Collection Systems	The MITRE Corp.	148,787 *
39-1(2)	A Modular Approach to On-Board Automatic Data Collection Systems—Seminar	The MITRE Corp.	26,141
AREA 40: PLANNING—IMPACT ANALYSIS			
40-1	Simplified Guidelines for Evaluating Transit Options in Small Urban Areas	Barton-Aschman	149,960 *
40-2	Estimating Incremental Costs of Bus-Route-Service Changes	Sydec, Inc.	154,781
40-3	Strategies to Implement Benefit-Sharing for Fixed-Transit Facilities	SG Associates	99,957 *
AREA 43: DESIGN—TRACK AND ANCILLARY SYSTEMS			
43-1	Detection of Low-Level Fault Currents on Rail Transit Systems	Chas. T. Main, Inc.	99,913 *
AREA 46: DESIGN—GENERAL DESIGN			
46-1	Single Cable Communications Technology for Rail-Transit Systems	Poly Inst of NY	150,000
AREA 47: MATERIALS AND CONSTRUCTION—GENERAL MATERIALS			
47-1	Improved Service Life of Urban Transit Coach Brakes	Battelle Mem Inst	300,000
AREA 48: MATERIALS AND CONSTRUCTION—SPECIFICATIONS, PROCEDURES, AND PRACTICES			
48-1	Corrosion Attributed to DC Powered Transit Systems	IIT Research Inst.	200,000
AREA 54: OPERATIONS—ENERGY EFFICIENCY			
54-1	Improve Transit Bus Energy Efficiency and Productivity	Booz-Allen	39,976 *
54-2	Energy Management of Electric Rail Transit Systems	Carnegie-Mellon	150,000 *
AREA 55: OPERATIONS—PERFORMANCE, EFFECTIVENESS, AND EFFICIENCY			
55-1	Conversion to One-Person Operation of Heavy-Rail Rapid-Transit Trains	Battelle Mem Inst	150,000

* Final Subcontract cost.

† Continuing activity through FY '84. Annual amount varies; total to date shown.

‡ Allocated—Balances are carried forward to support future synthesis studies.

STARTING DATE	EXPECTED COMPLETION DATE	PROJECT STATUS (for details, see latest Summary of Progress)	PROJECT NO.
11/8/82	8/7/84	Completed—Manual published as NCTRP Report 11; research report available on a loan basis	30-1
11/30/81	12/15/82	Completed—Published as NCTRP Report 2	31-1
10/1/85	12/31/86	Completed—Report in review stage	31-2
10/15/81	4/14/84	Completed—Report summarized in RRD 3; see Prog. by Proj. section for rpt. avail.	33-1
11/1/82	2/29/84	Completed—Published as NCTRP Reports 5 and 6	33-2
12/1/84	9/1/86	Completed—Research report available on a loan basis	33-2(2)
11/1/83	10/31/84	Completed—Published as NCTRP Report 10	33-3
11/2/81	11/1/83	Completed—Published as NCTRP Report 4	36-1
2/2/86	3/31/87	Research in progress	36-1(2)
1/3/83	1/31/85	Completed—Report summarized in RRD 4; see Prog. by Proj. section for rpt. avail.	38-1
4/1/85	1/15/87	Completed—Research report available on a loan basis	38-1(2)
11/1/82	8/31/84	Completed—Published as NCTRP Report 9	39-1
8/12/85	7/11/86	Completed—Summary published as RRD 5; see Prog. by Proj. for rpt. avail.	39-1(2)
10/25/82	10/23/84	Completed—Published as NCTRP Report 8	40-1
11/15/83	2/28/87	Research in progress	40-2
11/1/83	2/1/85	Completed—To be published as NCTRP Report 12	40-3
1/3/83	11/30/84	Completed—Published as NCTRP Report 7	43-1
5/1/84	9/30/85	Completed—Agency rpt. avail. for loan or purchase; to be publ. if funds permit	46-1
12/1/81	11/30/84	Completed—To be published as NCTRP Report 14	47-1
9/1/85	3/31/87	Research in progress	48-1
10/1/81	6/30/82	Completed—Published as NCTRP Report 1	54-1
10/1/81	12/31/83	Completed—Published as NCTRP Report 3	54-2
3/5/84	12/31/85	Completed—To be Published as NCTRP Report 13 if funds permit	55-1

TABLE I (Continued)
SUMMARY OF STATUS THROUGH DECEMBER 31, 1985, FOR FY '80 THROUGH FY '84 PROJECTS

PROJECT		RESEARCH AGENCY	SUBCONTRACT AMOUNT OR SUBCONTRACT COST (\$)
NO.	TITLE		
AREA 60: SPECIAL PROJECTS			
60-1	Synthesis of Information Related to Transit Problems	TRB	660,000 ^a
	TS-1: Cleaning Equipment and Procedures for Transit Buses	ATE Mgmt	75,000 ^b
	TS-2: Priority Treatment for Buses on Urban Streets	PAWA	75,000 ^b
	TS-3: Effects of Fuel Additives and Alternative Fuel Grades for Transit Buses	Southwest Res Inst	30,000 ^b
	TS-4: Guidelines for Allocation of Time for Transit Coach Maintenance Functions	XYZYX Info Corp.	30,000 ^b
	TS-5: Extraboard Management Procedures and Tools	L. C. McDorman	40,000 ^b
	TS-6: Traffic Control and Regulation at Transit Stops	W. W. Rankin	45,000 ^b
	TS-7: Bus Communications Systems	Mitre	45,000 ^b
	TS-8: Passenger Information Systems for Transit Transfer Facilities	J. J. Fruin	45,000 ^b
	TS-9: Transit Fare Collection: Problems and Alternatives to Paper Currency	Mitre	75,000 ^b
	TS-10: Use of Part-Time Operators	L. C. McDorman	50,000
	TS-11: Transit Marketing: Success and Failures	Richard L. Oram	50,000
	TS-12: Use of Incentives to Attain Specified Performance Standards in Collective Bargaining for Mass Transit	Darold T. Barnum	50,000
	TS-13: Bus Inspection Guidelines	C. I. Giuliani	50,000

TABLE II
PUBLISHED REPORTS OF THE NATIONAL COOPERATIVE TRANSIT RESEARCH & DEVELOPMENT PROGRAM

Report			
No.	Title	Pages	Price
1	Transit Bus Energy Efficiency and Productivity—Bus Equipment Selection Handbook (Project 54-1),	55p.,	\$7.20.
2	Impacts of Federal Grant Requirements on Transit Agencies (Project 31-1),	73 p.,	\$7.60
3	Reduction of Peak-Power Demand for Electric Rail Transit Systems (Project 54-2),	142 p.,	\$10.40
4	Improving Decision-Making for Major Urban Transit Investments (Project 36-1),	47 p.,	\$7.20
5	Assessment of Quality of Work-Life Programs for the Transit Industry—Research Report (Project 33-2),	99 p.,	\$8.80
6	Assessment of Quality-of-Work-Life Programs for the Transit Industry—Model Programs (Project 33-2),	37 p.,	\$6.80
7	Detection of Low-Current Short Circuits (Project 43-1),	216 p.,	\$14.00
8	Simplified Guidelines for Evaluating Transit Service in Small Urban Areas (Project 40-1),	119 p.,	\$10.40
9	Modular Approach to On-Board Automatic Data Collection Systems (Project 39-1),	123 p.,	\$10.40
10	Public Transit Bus Maintenance Manpower Planning (Project 33-3),	56 p.,	\$8.00
11	Small Transit Vehicles: How to Buy, Operate, and Maintain Them (Project 30-1),	49 p.,	\$7.60
12	Strategies to Implement Benefit Sharing for Fixed Transit Facilities (Project 40-3),	214 p.,	\$14.00
13	Conversion to One-Person Operation of Rapid Transit Trains (Proj. 55-1),	(In Preparation)	
14	Improved Service Life of Urban Transit Coach Brakes (Proj. 47-1),	(In Preparation)	

Synthesis of Transit Practice

No.	Title	Pages	Price
1	Cleaning Transit Buses: Equipment and Procedures (Proj. 60-1, Topic TS-1),	39 p.,	\$6.80
2	Enforcement of Priority Treatment for Buses on Urban Streets (Proj. 60-1, Topic TS-2),	30 p.,	\$6.40
3	Diesel Fuel Quality and Effects of Fuel Additives (Proj. 60-1, Topic TS-3),	62 p.,	\$7.60
4	Allocation of Time for Transit Bus Maintenance Function (Proj. 60-1, Topic TS-4),	24 p.,	\$6.40
5	Extraboard Management: Procedures and Tools (Proj. 60-1, Topic TS-5),	38 p.,	\$7.60
6	Transit Bus Fare Collection: Problems with and Alternatives to Paper Currency (Proj. 60-1, Topic TS-9),	20 p.,	\$6.80
7	Passenger Information Systems for Transit Transfer Facilities (Proj. 60-1, Topic TS-8),	39 p.,	\$7.60
8	Bus Communication Systems (Proj. 60-1, Topic TS-7),	23 p.,	\$7.20
9	Use of Part-Time Operators (Proj. 60-1, Topic TS-10),	33 p.,	\$7.60

STARTING DATE	EXPECTED COMPLETION DATE	PROJECT STATUS (for details, see latest Summary of Progress)	PROJECT NO.
11/7/80	*	Research in progress	60-1
2/16/81	12/31/81	Completed—Published as NCTRP Synthesis 1	(TS-1) 60-1
3/16/81	12/31/81	Completed—Published as NCTRP Synthesis 2	(TS-2) 60-1
10/1/82	9/30/83	Completed—Published as NCTRP Synthesis 3	(TS-3) 60-1
12/9/82	11/30/83	Completed—Published as NCTRP Synthesis 4	(TS-4) 60-1
11/31/83	10/31/84	Completed—Published as NCTRP Synthesis 5	(TS-5) 60-1
12/27/83	9/30/85	Completed—Report in editorial and publication process	(TS-6) 60-1
11/21/83	3/31/85	Completed—Published as NCTRP Synthesis 8	(TS-7) 60-1
11/21/83	12/31/84	Completed—Published as NCTRP Synthesis 7	(TS-8) 60-1
12/2/83	12/31/84	Completed—Published as NCTRP Synthesis 6	(TS-9) 60-1
11/15/84	3/31/86	Completed—Published as NCTRP Synthesis 9	(TS-10) 60-1
11/15/84	5/31/86	Completed—Report in review stage	(TS-11) 60-1
12/1/84	6/30/86	Completed—Report in review stage	(TS-12) 60-1
11/15/84	3/31/86	Completed—Report in editorial and publication process	(TS-13) 60-1

TABLE III
NCTRP RESEARCH RESULTS DIGESTS *

DIGEST NO.	PROJ. NO.	TITLE, PAGES, PRICE
1	33-1	Review of Literature Related to Bus Operator Stress, 15p., \$3.00
2	60-1	Project to Synthesize Information on Transit Problems, 3p., \$1.00
3	33-1	Predicting and Dealing with Bus Operator Stress, 4 p., 1.00
4	38-1	National Transit Computer Software Directory, 9 p., \$1.00
5	39-1(2)	Modular Approach to One-Board Automatic Data Collection System—Seminar, 7 p., \$3.00

* See Table I for project titles. See final page of this document for ordering information.

- 54-1 Completed—Published as NCTRP Report 1
- 54-2 Completed—Published as NCTRP Report 3
- 60-1 Completed—Published as NCTRP Syntheses 1 and 2

Steps were taken as appropriate to circumstances to close contracts, pay final vouchers, and disband project panels.

In general, the full details of the status of all FY '80 projects that were active during the report period will be found in the "Progress by Project" section and Tables I, II, and III of this document.

In line with the requirements of Contract DTUM60-81-C-72012, Article XIX, Subcontracting Reporting Requirements, it is reported that no subcontracts for research under the FY 1980 program were entered into during the 6 months ending December 31, 1986.

FY 1981 Program

The program recommended to UMTA by the TSG was referred to TRB by UMTA, consisting of six projects and two syntheses funded at \$985,000. It was referred on May 30, 1982 to the Academy for administration, and all projects are completed. Six regular reports, two Research Results Digests, and two synthesis reports have been pub-

lished and delivered to UMTA. A brief summary of the status of the FY '81 projects is:

- 30-1 Completed—Manual published as NCTRP Report 11; research report will not be published.
- 33-2 Completed—Published as NCTRP Reports 5 and 6; FY '82/'83 continuation is under way.
- 38-1 Completed—Final report is available for loan—Published as NCTRP Digest 4; FY '82/'83 continuation is under way.
- 39-1 Phase I Completed—Published as NCTRP Report 9.
Phase II (Project 39-1(2)) Completed—Published as NCTRP Digest 5.
- 40-1 Completed—Published as NCTRP Report 8.
- 43-1 Completed—Published as NCTRP Report 7.
- 60-1 Completed—This year's work published as NCTRP Syntheses 3 and 4.

Steps were taken as appropriate to circumstances to close contracts, pay final vouchers, and disband project panels.

In general, the full details of the status of all FY '81

projects that were active during the report period will be found in the "Progress by Project" section and Tables I, II, and III of this document.

In line with the requirements of Contract DTUM60-81-C-72012, Article XIX, Subcontracting Reporting Requirements, it is reported that no subcontracts for research under the FY 1981 program were entered into during the 6 months ending December 31, 1986.

FY 1982/1983 Program

NOTE: Formerly designated as the FY 1982 Program, the new designation was requested by UMTA so that succeeding-year designations will correspond more closely with actual fiscal years.

The TSG met in October 1982 and developed the FY '82/'83 program. Recommended to UMTA were two continuations, four syntheses, and six new projects. One new project was subsequently converted to a synthesis study. UMTA approval action on the recommendations was taken according to funds available (\$990,000), and official referral of the final program to the Academy for administration was made on January 13, 1983. All studies have been initiated, and two regular reports and three synthesis reports have been published and delivered to UMTA.

Initiation of research depended on the provision of funds under a new contract. The reason for this was that the original contract was for four years, the last two of which provided for closing down the operation in the event that UMTA chose not to continue it. With development and referral of the third program of research projects, either a new contract or modification of the existing one became necessary. UMTA's election was for a new contract that would run concurrently with the existing one, and it was on this basis that a proposal was submitted to UMTA in May 1983. Although the contract was for \$6 million, this amount will not be realized as UMTA is not providing the funding requested for each of the four years, thus limiting the size of each annual program. A brief summary of the status of the FY '82/'83 projects is:

- 33-2(2) Completed—Research report will not be published
- 33-3 Completed—Published as NCTRP Report 10
- 38-1(2) Research is in progress
- 40-2 Research is in progress
- 40-3 Completed—Published as NCTRP Report 12
- 46-1 Completed—Report to be published if funds permit
- 55-1 Completed—To be Published as NCTRP Report 13 if funds permit
- 60-1 Five syntheses completed—Four published, one to be published if funds permit

Studies TS5, TS7, TS8, and TS9 have been published as Syntheses 5, 8, 7, and 6, respectively; TS6 will be published if funds permit.

In line with the requirements of Contract DTUM60-83-C-71226, Article XIX, Subcontracting Reporting Requirements, it is reported that no subcontracts were entered into during the 6 months ending December 31, 1986.

FY 1984 Program

This program was developed by the TSG in October 1983 and referred to the Academy on May 10, 1984. The and one continuation with research funding of \$680,000 (this includes funds for the two continuation projects authorized in FY 1982/1983). Research agencies for the two regular projects were selected at project panel meetings in June 1985 and were placed under contract in the fall of 1985. One hundred forty-two problems were candidates for funding. Once again, the level of detail and quality of statements remained high in general. It is hoped that the large number of candidates is indicative of a growing awareness in the transit industry of what the NCTRP is all about and a mounting interest in the service it can provide. A larger funding base is needed so that the transit industry can have a reasonable share of its problems researched. A brief summary of the status of these projects is:

- 31-2 Research is in progress
- 36-1(2) Research is in progress
- 48-1 Research is in progress
- 60-1 Four syntheses (TS10 through TS13) are in progress

In line with the reporting requirements of Contract DTUM60-83-C-71226, Article XIX, Subcontracting Reporting Requirements, it is reported that no subcontracts were entered into during the 6 months ending December 31, 1986.

A contract amendment is expected during the second half of 1986 to provide additional funds (\$213,000) required for technical monitoring and publication of final reports on the 8 projects and 5 syntheses that remain to be completed under the current contracts.

FY 1985 Program

This program was developed by the TSG in December 1984. The program has not yet been referred to the Academy by UMTA. The total funding level is not known, but it should be somewhere between \$900,000 and \$1,000,000, an amount sufficient to support but a few of the 108 problems submitted for consideration.

FY 1986 Program

All work under this program is contingent on the APTA contract for conduct of the TSG operation relative to formulation of annual programs and other responsibilities. The APTA process began January 1985 with the call for problems. Problems have not been submitted to the PTC for action. TSG activities have been suspended pending a contract extension.

General—All Programs

Distribution was made early in the report period of NCTRP Progress Report 9 to UMTA and others participating directly in NCTRP work. The Annual Summary of Progress for 1985 was published near the end of 1985 and received wide distribution through the TRB selective distribution process. Further distribution was also made at the January 1986 TRB Annual Meeting.

Difficulties Encountered During Report Period

1. Staff activity relative to administration of the program remains at a low-level, part-time basis for the reasons given in Progress Report 7 and will continue so until there is a realistic approach to the matter of costs necessary for proper administration of the program.

Difficulties Projected for Next Report Period

As has been the past case, what happens here depends on availability of funds to support the FY 1985 program developed by the TSG. Certain administrative functions can be carried forward to some extent; however, the bulk of program activity will have to await a contract amend-

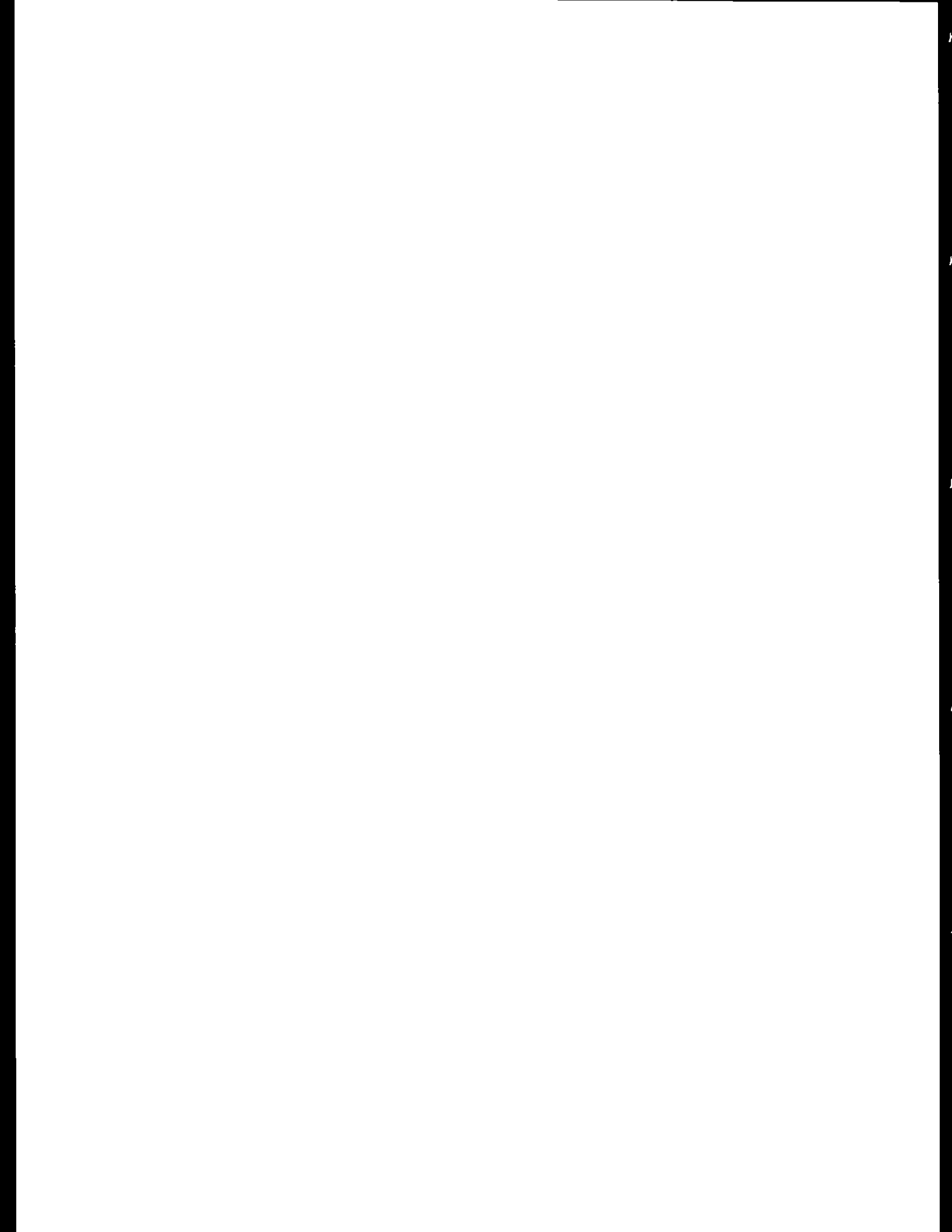
ment by which funds to support subcontracts will be provided.

PTC Activities in the Next Report Period

1. Routine surveillance of studies under contract.
2. Follow-up as appropriate on projects reaching expiration dates.
3. Approval and acceptance processes on receipt of FY '85 program officially referred from UMTA.
4. Formulation of project panels and meetings to write Project Statements for FY '85 research.
5. Solicitation of proposals.
6. Preparation for project panel meetings to select research agencies.
7. Preparation of a 6-month progress report for the period ending June 30, 1987.

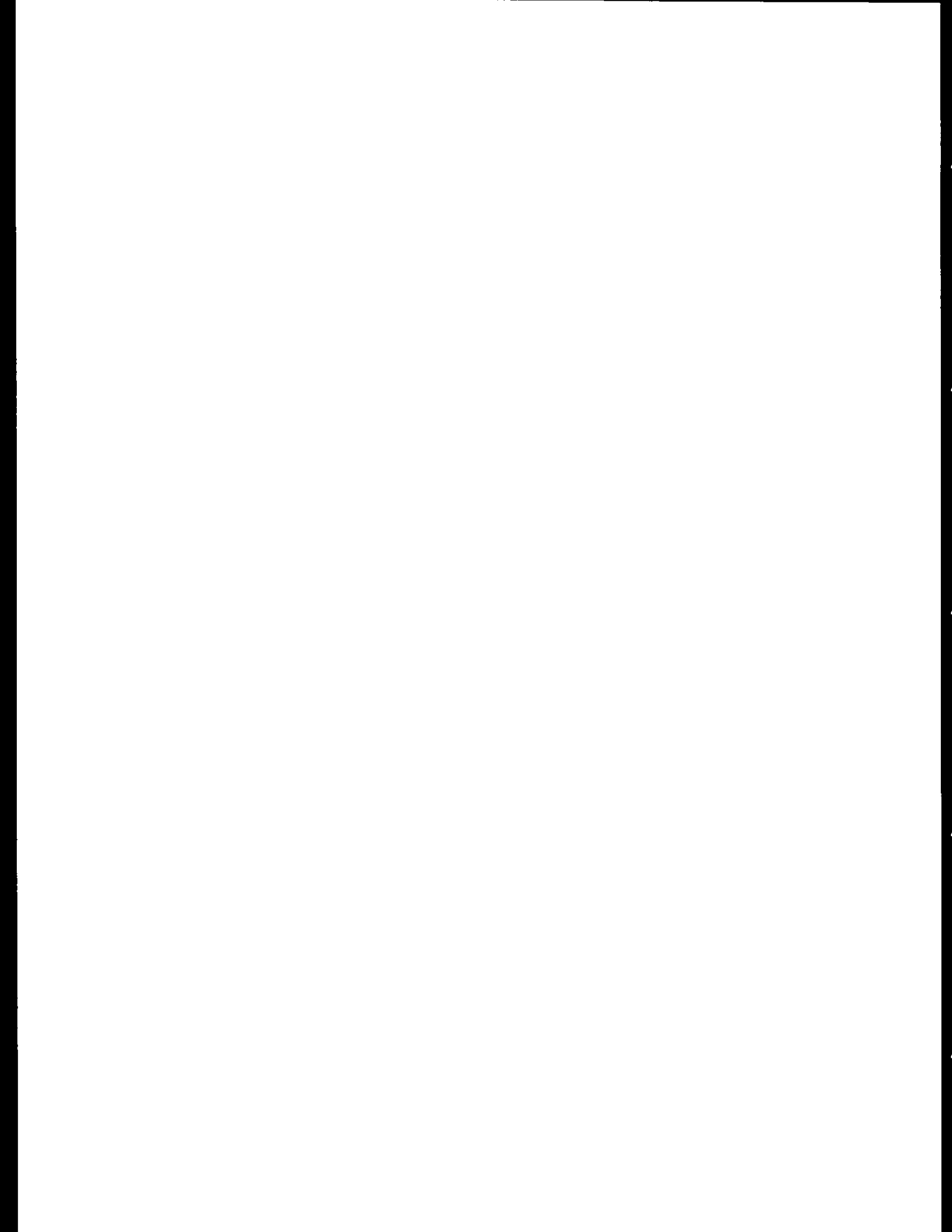
AWARD-WINNING RESEARCH UNDER NCTRP

- NCTRP Project 40-3, "Strategies to Implement Benefit-Sharing for Fixed Transit Facilities." In 1986, this project, reported as *NCTRP Report 12*, "Strategies to Implement Benefit-Sharing for Fixed-Transit Facilities," received the Category III Award of the National Capital Area Chapter of the American Planning Association's 1986 Awards Program.



PROGRESS BY PROJECTS

The following pages present detailed status reports on those projects for which there remains any type of contractual activity. The status of *all* projects can be found in Table I.



AREA THIRTY: ECONOMICS

Project: 30-1, FY '81
Title: Small Transit Buses: A Manual for Improved Purchasing, Use, and Maintenance

Research Agency: Arthur D. Little, Inc.
Principal Investigator: Dr. P. Ranganath Nayak

Effective Date: November 8, 1982
Completion Date: August 7, 1984

AGENCY PERFORMANCE

1. Is the project on schedule? Yes Percent project complete: 100
2. Is the research in keeping with the approved research plan: Yes
3. Subcontract Amount: \$299,378
4. Estimated Expenditures to 12/31/86: \$299,378
5. Are the expenditures in keeping with the project progress? Yes

PROJECT DESCRIPTION

One of the important decisions facing both rural and urban transit decisionmakers is whether to invest scarce funds in more expensive or less expensive small transit buses. Available small buses (i.e., ranging from van conversions to 31-ft heavy-duty small buses) are highly diverse in both capital costs and technology. Their uses are also highly diverse, spanning the range from large transit fleets in major urban areas to small rural operators, and including fixed-route, demand-responsive, shuttle and other services. The complexity of both needs and possible solutions has led to many poor choices of buses for specific duties. In addition, uncertainties with respect to the small bus market have led to a lack of continuity in design and development; perceived problems in bus operation, maintenance, and reliability; a lack of clear definition of bus demand; and little standardization within realistic price ranges. Consequently, no guidelines exist with which transit providers, seeking to purchase or replace small buses, can make objective decisions concerning the best bus type to be procured.

The general objective of this research is to develop a workbook-style manual for local transit operators and to identify key recommendations that might feasibly be taken by transit operators, local governments, states, and UMTA to substantially improve the procurement, appropriate use, and maintenance processes for small transit buses. The manual is intended for use by individuals experienced and inexperienced in the procurement and operation of small transit buses. Furthermore, the manual is intended to assist individuals in the cost-effective procurement, maintenance, and operation of buses in a wide range of local, institutional, service, and operating environments. (Included in the definition of service and operating environments are maximum and average loads; type of service; range requirements (i.e., distance between refueling); wheelchair-lift or ramp needs, and actual usage; types, conditions, and grades of roads/streets; dwell-time constraints; weather extremes; frequency and degree of acceleration/braking; communication equipment requirements; and fare collection equipment requirements). The manual will be based on research requiring the collection, tabulation, and analyses of primary information and data. While performing the research, investigators must be particularly cognizant of bus maintainability and fuel efficiency. (Included in the definition of maintainability are life expectancy of the bus's power train, body, and major components; minimum mean time before failure (MTBF) rates of components; availability and cost of parts; maintenance and servicing facilities required; skill levels and representative times and costs required for servicing and repair; complexity of subsystems (i.e., lifts and air conditioning).) Fuel efficiency studies should consider duty cycle, propulsion technology, maintenance, bus size and weight, gearing, etc. Transit operators will be the principal users of the research results, although they should also be of interest to manufacturers and funding agencies. To accomplish this objective the following tasks are considered essential but not limiting:

Project 30-1 continued

Task 1 - Determine the present capital and operating costs, and performance of small transit buses in U.S. operations as affected by (1) service and operating environments, (2) institutional environments, and (3) maintenance availability and sophistication.

A. Develop a classification system for small buses by type (life expectancy, maintainability, operating cost) and size.

B. Develop a classification system for operational environments and maintenance programs.

C. Develop a detailed data collection plan for use in determining capital and operating costs for various classes of buses, maintenance programs, and operating environments.

D. Collect data and summarize results for various bus and component classes to provide transit operators with relevant design characteristics and operating experience. Analyze MTBF data (as developed in this study or available elsewhere), design characteristics, and general operating experience for key components, subsystems, chassis types, etc. that are critical to the development of minimum specifications for various service and operating environments, appropriate maintenance actions, and realistic replacement intervals. Develop from these data an engineering analysis of each bus class describing its suitability for various types of service and likely operating results. Assess the practicality of using life-cycle costs to assist in the description of operating results.

E. Identify problems for transit operators and manufacturers in using or producing small transit buses that are supported by the data.

Task 2 - Develop practical recommendations for resolution of key problems, identified in the research, for improving the purchase, maintainability, and cost-effective use of small transit buses. These recommendations should be oriented towards actions that can be taken by transit operating agencies to improve delivery of service.

Task 3 - Based on the results of Task 1, develop a workbook (flow-chart type) manual that can be used by transit operators to make appropriate small bus choices. The manual should be designed to take as input such planning factors as service type, anticipated passenger loads, typical speeds, maintenance and institutional factors. Its output should include the classes of small transit buses that are best suited to the projected operating environment, special specification items or options that should be required, the range of maintenance and fuel costs likely to be experienced, and special maintenance provisions that should be undertaken.

STATUS OF RESEARCH

Research on this project is complete. A manual (NCTRP Report 11) has been developed that is based on a method to determine life-cycle costs that are, in turn, based on a maintenance data base representing 187 small buses from transit agencies geographically distributed throughout the United States. The method's strength lies in its sensitivity to duty cycle, climate, and other factors. It calls for the analyst to (1) determine capacity requirements, and (2) document the characteristics of the working environment. Through the use of simple equations, the analyst is led to the service type of bus (van, body on van chassis, body on truck chassis, purpose-built) providing the lowest life-cycle cost. Rauges in life cycle cost for a given bus type may also be determined.

Inasmuch as maintenance costs were found to vary with changes in duty cycle and climate, an analyst can use the maintenance cost results to determine appropriate operations for small buses.

The manual has been published as NCTRP Report 11, "Small Transit Vehicles: How to Buy, Operate, and Maintain Them." The research report has been modified in response to reviews. It will not be published.

AMENDMENT(S) THIS REPORTING PERIOD: None

PROBABILITY OF SUCCESS: The objectives have been successfully accomplished.

REPORT(S) AVAILABILITY: NCTRP Report 11, "Small Transit Vehicles: How to Buy, Operate and Maintain Them." Final Research Report, "Selection, Use, and Maintenance of Small Buses," is available on a loan basis (see final page of this document for ordering information).

Project 30-1 continued

PRINCIPAL INVESTIGATOR(S): Dr. P. Ranganath Nayak
Mgr., Transportation Systems Group
Arthur D. Little, Inc.
Acorn Park
Cambridge, MA 02140
617/864-5770

RESPONSIBLE NCTRP STAFF ENGINEER: Dan A. Rosen - 202/334-3231

AREA THIRTY-ONE: FINANCE

Project: 31-2, FY '84
Title: Transit Capital Investment to Reduce Operating
 Deficits: Alternative Bus Replacement Strategies

Research Agency: Fleet Maintenance Inc.
Principal Investigator: Richard Drake

Effective Date: October 1, 1985
Completion Date: October 31, 1986
Revised Completion Date: December 31, 1986

AGENCY PERFORMANCE

1. Is the project on schedule? Yes Percent project complete: 100
2. Is the research in keeping with the approved research plan? Yes
3. Subcontract Amount: \$150,000
4. Estimated Expenditures to 12/31/86: \$150,000
5. Are the expenditures in keeping with the project progress? Yes

PROJECT DESCRIPTION

The prudent expenditure of already limited capital and operating funds is especially important as plans to reduce federal contributions take shape. Budget proposals, if enacted, will eliminate federal operating funds while reducing transit capital funds to the proceeds of the \$0.01 gasoline tax. Beyond the federal cutbacks, raising money at state and local levels becomes increasingly difficult as transit programs are forced to compete with other community needs.

In the past, tradeoff decisions between capital and operating budgets were not necessary because funds were segregated by program category. More recently, it has been possible to use capital funds for operating purposes under certain conditions. Transit authorities are being asked to review the bases on which both capital and operating expenditures are made. Past policies and practices have tended to favor capital expenditures based on federal and state contributions as well as on regulations and requirements of different levels of government.

Since there are reasonable expectations that the availability of some level of capital funding will continue, even as operating assistance declines, it is prudent to explore the hypothesis that selected capital investments can reduce the need for operating funds in individual transit agencies.

There are numerous areas where capital expenditure can have a favorable impact on operating costs. For example, building a new maintenance facility, installing a two-way radio system, providing automatic vehicle monitoring, developing a computerized maintenance capability, replacing aging vehicles -- these and many other projects can be evaluated in terms of their impact on operating dollars. In particular, development of an appropriate strategy for replacement of the bus fleet is an area where additional research could result in significant operating cost savings. Past UMTA policy prescribed a minimum 12-year lifespan before a 40-ft conventional bus was eligible for replacement. UMTA is considering 500,000 miles, or similar yardsticks, as alternative bases for replacement. Because no replacement strategy has been validated technically, capital funds may be spent in advance of real need. Scarce operating dollars, in contrast, may continue to be expended in an inefficient manner to prolong the service life of a bus at inordinately high operating cost. A well-timed expenditure of capital funds to buy new buses actually could reduce the total of annual operating and capital costs, and improve reliability of passenger service.

The overall objective of this research is to adapt or develop methods for evaluating various capital investment opportunities that would provide transit operating agencies and transit funding agencies the means to measure improvements in operating efficiency and service which reduce or help control operating costs.

Project 31-2 continued

This study is expected to lead to the identification of various types of transit capital projects that can improve system performance including ridership, vehicle productivity, reliability, fleet availability, trip time savings, and cost savings. The first phase of research will focus specifically on bus replacement strategies and will include development of one or more methods for transit and funding agencies to evaluate alternative strategies. Annual operating and capital cost impacts should be outputs of the method(s) developed. If funds are available, it is possible that future research will concentrate on other types of capital expenditures.

The following tasks are suggested to further the overall general objective and to accomplish the specific objective of Phase I.

Task 1. Identify capital investment opportunities, other than bus replacement considered in Tasks 3 through 6, which would reduce transit operating deficits. From successes and failures described in the literature, recommend investment opportunities for research in future studies.

Task 2. For two or three of the recommended investment opportunities from Task 1, suggest tasks and data requirements necessary to accomplish possible future research, which is presently unfunded, to (a) develop appropriate methods to evaluate their impact on operating costs and operating deficits, and (b) develop appropriate methods for transit agencies to prioritize and select capital investment opportunities to produce cost-effective improvements in operating efficiency and service levels that reduce or help control operating costs. Include time and cost estimates for the research on each investment opportunity.

Task 3. Summarize past and current research on bus replacement schedules, life-cycle costing analyses, and bus purchasing guidelines. Describe the rationale for the 12-year replacement cycle. Identify the data bases to be used for Tasks 5 and 6.

Task 4. Identify current bus replacement practices of selected U.S. transit agencies of various sizes and geographic locations.

Task 5. Develop or adapt methods for transit and funding agencies' consideration to determine optimal fleet replacement schedules for different environments and funding sources. Such methods should consider vehicle-miles, vehicle-hours, duty cycle (terrain, number of stops), climate, fleet size and mix, level of preventive maintenance, spare ratio, bus rehabilitation policy, and data availability for use in the methods.

Task 6. Provide a total of three geographically diverse examples of methods application for hypothetical cases reflecting the real world for small, medium, and large agencies.

STATUS OF RESEARCH

All tasks have been completed. The final report has been reviewed by the project panel and a decision to publish the report in the NCTRP report series was made. However, publication of NCTRP reports has been suspended pending execution of a contract amendment to provide additional funds required for technical monitoring and report publication on currently active NCTRP projects.

AMENDMENT(S) THIS REPORTING PERIOD

<u>Date</u>	<u>No.</u>	<u>Type</u>	<u>Amounts and/or Dates (From/To)</u>	<u>Comments</u>
9/11/86	1	Time	10/31/86 - 12/31/86 (2 mos.)	Extension of contract termination date to provide additional time for report review and final editing.

PROBABILITY OF SUCCESS: Good

REPORT(S) AVAILABILITY: Final report, "Transit Capital Investment to Reduce Operating Deficits: Alternative Bus Replacement Strategies," is available on a loan basis from the Program Director, NCTRP.

PRINCIPAL INVESTIGATOR(S): Mr. Richard Drake, Senior Associate
Fleet Maintenance Consultants, Inc.
12695 Whittington Drive
Houston, TX 77077
713/496-7717

RESPONSIBLE NCTRP STAFF ENGINEER: Dan A. Rosen - 202/334-3231

AREA THIRTY-THREE: PERSONNEL MANAGEMENT

Project: 33-2(2), FY '82/83
Title: Quality-of-Work-Life Programs for the Transit Industry-Regional Seminars

Research Agency: Public Administration Service
Principal Investigator: Dr. Susan G. Clark

Effective Date: December 1, 1984
Completion Date: March 1, 1986
Revised Completion Date: September 1, 1986

AGENCY PERFORMANCE

1. Is the project on schedule? Yes Percent project complete: 100
2. Is the research in keeping with the approved research plan? Yes
3. Contract Amount: \$52,454
4. Estimated Expenditures to 12/31/86: \$52,454
5. Are the expenditures in keeping with the project progress? Yes

PROJECT DESCRIPTION

Under an initial NCTRP project, recommendations were made on the potential application of quality-of-work-life programs to transit agencies. These recommendations and the supporting research were documented in two reports: NCTRP Report 5, "Quality-of-Work-Life Programs for the Transit Industry - Final Report," and NCTRP Report 6, "Quality-of-Work-Life Programs for the Transit Industry - Model Programs." In order to ensure proper consideration of these findings and recommendations, a second project is needed to disseminate the results to the transit industry. After reviewing an array of strategies, NCTRP Project Panel A33-2 concluded that with the help of local sponsors, regional seminars would be the most productive means, given the financial resources anticipated for the project. The Panel has also judged that sufficient interest exists to warrant the seminar approach. The regional seminars will be based on the previous research and will address issues facing management, practitioners, labor, and others concerned with the development of human resources.

The objective of Project 33-2(2) is to conduct at least four regional seminars at locations geographically distributed across the nation. Maximum use will be made of volunteer, local sponsors and support in arranging and conducting the seminars. The agency selected to accomplish the project objective will be required to:

1. Provide the lead in organizing and conducting the seminars including arrangements with local sponsors for support. The selected agency will be responsible for preparing and making announcements to potential seminar participants with NCTRP approval.
2. Provide the agenda and prepare all seminar material, such as audiovisual aids, lesson plans, and handouts. Maximum advantage will be taken of the sequencing of seminars to appropriately modify the seminar material as needed. The NCTRP will be given the opportunity for prior reviews of all seminar material.
3. Turn over to the NCTRP, at the conclusion of the project, all seminar materials and a brief summary description of the seminars conducted. The seminar material will be in a form suitable for use by others in conducting additional group seminars and as instructional information for individuals. The seminar material and summary will be treated as the final report for the project.

Project 33-2(2) continued

STATUS OF RESEARCH:

All research has been completed. The four regional seminars were successfully conducted at Flint, Michigan; Washington, D.C.; Houston, Texas; and Los Angeles, California. The researchers concluded that:

"Workshops designed to disseminate the results and application of research findings were judged successful by the consultant team. Using a combination of transit speakers on substantive issues and consultants on process issues was particularly effective.

The transit speakers uniformly indicated that they benefited, by taking a fresh look at their own programs as they planned presentations and as they responded to questions. Participants, as seen in the evaluations, judged the material to have strong applicability to their work. The union/management interaction was particularly stimulating. We think the workshops provided a unique opportunity for managers and union leaders to identify areas of mutual concern and benefit through application of quality of work life.

The impressions we have gained from some seminar participants is that current conditions in the transit industry may not be conducive to further development of Quality of Work Life (QWL), at this time. But, this does not mean QWL would not be beneficial to the industry. Quality of work life is an approach to organizational change that stresses human resource development, employee participation in decision-making, and productivity improvement. Our impression of the industry is that there is considerable variance of emphasis on productivity improvement and human resource development. In some instances this tends to increase adversarial labor-management relations and diminish opportunities for joint problem solving. However, our research demonstrated that QWL was applicable to the transit industry, and it illustrated numerous successes. We advocate that industry and union leaders take a closer look at this approach to change."

AMENDMENTS(S) THIS REPORTING PERIOD: None

PROBABILITY OF SUCCESS: Good

REPORT(S) AVAILABILITY: (1) Phase I reports, NCTRP Report 5, "Assessment of Quality-of-Work-Life Programs for the Transit Industry: Research Report," and NCTRP Report 6, "Assessment of Quality-of-Life Work Programs for the Transit Industry: Model Programs" (2) The Phase II reports, "Summary Report Quality-of-Work-Life Programs for the Transit Industry-Regional Seminars," is available on a loan basis (see last page of this report for ordering information). The summary report, together with the seminar materials, is being planned for publication and distribution by the U.S. Department of Transportation's Technology Sharing Program.

PRINCIPAL INVESTIGATOR: Dr. Susan G. Clark
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703/734-8970

RESPONSIBLE NCTRP STAFF ENGINEER: Dan A. Rosen - 202/334-3231

AREA THIRTY-SIX: ALTERNATIVE ANALYSIS

Project: 36-1(2), FY '84
Title: Assessment of Current Planning Practice for Major Transit Investments
Research Agency: Sydec, Inc.
Principal Investigators: Joseph R. Stowers
Effective Date: February 2, 1986
Completion Date: October 31, 1986
Revised Completion Date: March 31, 1987

AGENCY PERFORMANCE

1. Is the project on schedule? No* Percent project complete: 25
2. Is the research in keeping with the approved research plan? No*
3. Subcontract Amount: \$30,000
4. Estimated Expenditures to 12/31/86: \$5,000
5. Are the expenditures in keeping with the project progress? Yes

*Contract amended to reflect delayed starting date. However, project activity is now being delayed awaiting issuance of the UMTA guidelines - See "Status of Research" section.

PROJECT DESCRIPTION

Over the past 10 years, the Urban Mass Transportation Administration has developed and applied a structured process for planning of major transit projects proposed for Federal funding assistance. The process is used by both local and Federal officials to make a series of decisions on the location, nature, and design of major new transit facilities.

Ideally, the technical work conducted in each phase of the process yields the information necessary to permit informed judgments at each decision point. However, integration of the technical work into decision-making has proven to be challenging. While the basic premises and structure of the process have remained unchanged, it has evolved as UMTA has made revisions in an effort to both streamline the technical work and clarify the decision points. Furthermore, the accumulated experience in the various technical fields has improved the quality and efficiency of many aspects of the analysis.

In an effort to examine the degree to which the technical work actually contributes to informed decision-making, NCTRP Report 4, "Decision-Making for Major Urban Transit Investments," examined a series of case studies that included projects developed within and outside of UMTA's early process. The report examined the extensiveness of study requirements, the role of technical information in decision-making at the local level, and the management and costs of studies in various phases of the process. While the report was generally supportive of the requirements, it also provided a series of recommendations to improve the process and the relevance of the information produced and to promote more efficient and timely analysis.

Because of the focus on case studies in NCTRP Report 4, its results and recommendations reflect UMTA's requirements as they were several years ago. Meanwhile, the process has continued to evolve as set forth in more recent references:

1. May 18, 1984, Federal Register policy statement.
2. "Procedural Guidelines for Alternatives Analysis," January 1984.
3. "Sample Outline for DEISs Produced in Alternatives Analysis," January 1984
4. "Technical Guidelines for Alternatives Analysis," January 1984.

Project 36-1(2) continued

Taken together, these documents reflect a matured technical process that strives to embrace "best practice" in all aspects of the analysis. The documents establish, for the first time, a clear benchmark with which to examine UMTA's recommendations on the process, the scope of the technical work, and the structure of the reports. They provide an opportunity to evaluate what has become standard planning practice in the field, to examine its consistency with the recommendations in NCTRP Report 4, and to recommend any further improvements that may be needed.

The general objective of this research is to evaluate the state of the art of technical work undertaken throughout the planning process for major urban transit investments with emphasis on the alternative analysis phase. The evaluation should lead to recommended improvements in UMTA's alternatives analysis guidelines (specifically the technical guidelines and sample DEIS outline for DEIS) that will allow them to stand for the coming years without major modification. The development of evaluation criteria should consider at least four areas of concern: (1) methods to produce, during alternatives analysis, capital and operating cost estimates that are more likely to be confirmed rather than substantially revised during preliminary engineering; (2) guidelines on the depth of environmental analyses appropriate to the stage in the process; (3) measurement of benefits; and (4) assessment of the financial implications of both construction and operation of each alternative.

The following tasks are anticipated:

Task 1. Participate in a two-day project panel workshop conducted to critique the UMTA alternatives analysis guidelines. The workshop will involve assessments of the nature and level of effort of technical work that should be accomplished, to ameliorate the areas of concerns, during alternatives analysis for each of the seven technical areas covered in the guidelines (definition of alternatives, conceptual engineering and capital costs, operations planning and operating costs, patronage, environmental impacts, financial planning, and evaluation). Because of their interface with alternatives analysis, the technical work done in both systems planning and preliminary engineering may also be considered, though only to the extent necessary to clarify appropriate efforts during alternatives analysis. The findings of the workshop will lead to the development of a panel consensus on potential improvements to the guidelines that could be expected to result in more appropriate levels of technical work by transit agencies.

Task 2. Amplify the working plan to accomplish Tasks 3 through 5. Prepare draft survey of transit agencies and others responsible for major transit studies.

NOTE: One month should be allowed for NCTRP review and comment on the amplified working plan. Tasks 3 and 4 should proceed concurrently after UMTA completes any revisions to the guidelines based on the panel workshop.

Task 3. Evaluate proposed improvements to guidelines.

Task 4. Survey appropriate transit agencies and other responsible officials to document success or probable success of potential improvements.

Task 5. Develop recommendations to UMTA on changes to guidelines for technical work and to transit and other local agencies that will enable them to program appropriate technical work levels and otherwise improve the quality of alternatives analysis studies.

STATUS OF RESEARCH

The project panel met February 24 and 25, 1986, to evaluate UMTA's current guidance to transit agencies about to undertake, or presently undertaking, alternatives analysis. At this meeting the research agency was guided in its selection of case studies to augment information gained from the panel. Task 2 has been completed. Tasks 3 and 4 have just begun following UMTA's issuance of, "Review Draft, Procedures and Technical Methods for Transit Project Planning."

Project 36-1(2) continued

AMENDMENT(S) THIS REPORTING PERIOD

<u>Date</u>	<u>No.</u>	<u>Type</u>	<u>Amounts and/or Dates (From/To)</u>	<u>Comments</u>
11/12/86	2	Time	8/31/86 - 3/31/87 (7 mos.)	Contract period extended to account for delay while awaiting UMTA's issuance of alternative analysis guidelines.

PROBABILITY OF SUCCESS: Good

REPORT(S) AVAILABILITY: None

PRINCIPAL INVESTIGATOR: Mr. Joseph R. Stowers
Sydec, Inc.
1601 Washington Plaza
Reston, VA 22090
703/435-7075

RESPONSIBLE NCTRP STAFF ENGINEER: Dan A. Rosen - 202-334-3231

AREA THIRTY-EIGHT: SYSTEM PLANNING

Project: 38-1(2), FY '82/'83
Title: National Transit Computer Software Directory,
Phase II

Research Agency: COMSIS Corporation
Principal Investigator: Diane Ricard

Effective Date: February 1, 1985
Completion Date: March 31, 1986
Revised Completion Date: January 15, 1987

AGENCY PERFORMANCE

1. Is the project on schedule? Yes Percent project complete: 100
2. Is the research in keeping with the approved research plan? Yes
3. Subcontract Amount: \$50,000
4. Estimated Expenditures to 12/31/86: \$50,000
5. Are the expenditures in keeping with the project progress? Yes

See "Comments" under "Amendment(s) this Reporting Period."

PROJECT DESCRIPTION

Project 38-1 has produced a National Transit Computer Software Directory containing almost 300 transit application programs. These programs are listed in a catalog by: (1) the function they perform, (2) the submitting organization, and (3) the type of hardware on which the program operates. The catalog is accompanied by full-page descriptions for each of the approximately 300 programs. Furthermore, software has been developed to retrieve programs meeting various specifications. The software for this search process is described in a third document, "A Programming Guide." It is the full-page program descriptions that will be of greatest interest to transit agencies. These full-page descriptions need to be disseminated throughout the industry in an effective way. Furthermore, additional programs are known to UMTA which are believed to be of sufficient importance to add to the Directory immediately.

The general objective of this continuation research is to supplement the Directory and disseminate program descriptions among interested parties in the transit industry. Through dissemination of the program descriptions, it is envisioned that additional programs will be requested of agencies and subsequently added to the Directory. The following tasks will be performed.

Task 1. Categorize the full-page program descriptions by hardware type into six major groupings as follows:

<u>Hardware Type</u>	<u>Approximate Number of Programs</u>
IBM 360/370	38
IBM 30xx Series (3033,3081)	
AMDAHL	
BURROUGHS 1855, 1955	29
IBM 43xx Series (4331, 4341)	50
IBM System 3x Series (System 34, 338)	45

Project 38-1(2) continued

ALL OTHER MAINFRAME & MINI (CDC, DG, VAX, DEC, HP3000, IME, UNIVAC)	64
ALL MICROCOMPUTERS (Apple, PC, XT, TRS)	54

Within each of these hardware types, programs could be classified by functional type. Each of the six hardware types should be bound separately and produced in sufficient quantity to satisfy user request. Furthermore, each type should have an appendix containing the program documentation forms to be used for submitting new programs for the Directory.

Task 2. Prepare a Research Results Digest of not more than 10 printed pages to describe the accomplishments of Phase I, the availability of the six Directory material groupings, and the opportunity to request program descriptions meeting more specific criteria.

Task 3. Contact should be made with Tom Hillegass of UMTA or his designee to identify those programs known to UMTA that are not presently included in the Directory. Documentation for these programs should be obtained and added to the Directory.

Task 4. A follow-up should be made of requestors for program descriptions to evaluate the usefulness of the information sent them and to request programs that they might have that would be useful additions to the Directory.

Task 5. Prepare a final report that will update the preliminary draft report from Phase I. This report will be reviewed by the NCTRP.

Task 6. Revise the draft final report and submit the final version in fulfillment of the technical obligations under the contract for the project.

STATUS OF RESEARCH

All research is complete. The final report and the software directory will not be published in the regular NCTRP report series but will be available on a loan basis. The UMTA representative on the project panel is currently working on arrangements for an electronic bulletin board as a more practical means of updating and disseminating the programs in the software directory.

AMENDMENT(S) THIS REPORTING PERIOD:

<u>Date</u>	<u>No.</u>	<u>Type</u>	<u>Amounts and/or Dates (From/To)</u>	<u>Comments</u>
In Process	2	Time	8/31/86 - 1/15/87 (4.50 mos.)	Additional time required to revise final report in accordance with project panel comments.

PROBABILITY OF SUCCESS: Good

REPORT(S) AVAILABILITY:

1. NCTRP Research Results Digest 4, "National Transit Computer Software Directory" (see final page of this document for ordering information).

2. "Software Directory", six-volume directory categorized by hardware type as described in Task 1, containing page-long descriptions of almost 300 transit-related computer programs is available on a loan basis from the Director, CRP.

Project 38-1(2) continued

3. Final report, "National Transit Computer Software Directory," is available on a loan basis.

PRINCIPAL INVESTIGATOR(S): Ms. Diane Ricard
COMSIS Corporation
11501 Georgia Avenue
Bethesda, MD 20902
301/933-9211

RESPONSIBLE NCTRP STAFF ENGINEER: Dan A. Rosen - 202/334-3231

AREA THIRTY-NINE: ROUTE PLANNING

Project: 39-1(2), FY '81
Title: A Modular Approach to On-Board, Automatic Data
Collection Systems--Seminar

Research Agency: The MITRE Corporation
Principal Investigator: Lawrence E. Deibel

Effective Date: August 12, 1985
Completion Date: May 11, 1986
Revised Completion Date: July 11, 1986
Estimated Completion Date: August 15, 1986

AGENCY PERFORMANCE

1. Is the project on schedule? No* Percent project complete: 98
2. Is the research in keeping with the approved research plan? Yes
3. Subcontract Amount: \$26,141
4. Estimated Expenditures to 12/31/86: \$26,141
5. Are the expenditures in keeping with the project progress? Yes

* See "Status of Research" section.

PROJECT DESCRIPTION

NCTRP Project 39-1 demonstrated the potential for using a modular approach to automatically collect data on board transit buses. The findings of this project have been published in National Cooperative Transit Research & Development Program Report 9, "Modular Approach to On-Board Automatic Data Collection Systems." The report contains technical specifications for various modular units and for the totally configured system on board a bus. Guidelines to help the practitioner evaluate the utility of automatically collecting data and to assist in the design and implementation of automatic data collection on a systemwide basis are also provided.

The recommended modular configuration is intended to provide flexibility to transit agencies and encourage competition in the marketplace. A truly modular system permits step-by-step implementation, which may be required by budget constraints or perceived present needs. A modular approach also provides the capability to accommodate unforeseen future data requirements or to update modules without the need to redesign or purchase an entirely new system. However, because a universally applicable modular approach is not now standardized, implementation of the concept will require agreement among at least several transit agencies or manufacturers, or preferably both. Specific agreement will also be necessary on a standard interface to allow the greatest degree of flexibility in the selection of the various modules.

The objective of Project 39-1(2) is to provide a forum for the discussion and advancement of the planning techniques and the modular approach for on-board automatic data collection systems for transit buses as reported in National Cooperative Transit Research & Development Program Report 9. To accomplish this objective, at least the following tasks are envisioned.

Task 1. Plan and make all preparations for the seminar that will include transit users and the manufacturers or suppliers of automatic fare and passenger data collection equipment including associated hardware and software. Contact with the American Public Transit Association (APTA) and the Urban Mass Transportation Administration (UMTA) should be made for any additional support their organizations could provide. (For example, this seminar could be conducted in conjunction with other meetings attended by participants having similar interests.) This task will include making announcements to potential seminar participants with NCTRP approval and making arrangements for the seminar facilities.

Project 39-1(2) continued

Task 2. Provide the agenda and prepare all seminar materials, such as audiovisual aids and handouts. (A supply of NCTRP Report 9 copies can be provided by TRB for the participants.) The NCTRP will be given the opportunity for prior review of all seminar material.

Task 3. Conduct the seminar. It is expected that the seminar will include not only presentation but working type sessions to assess the findings of NCTRP Report 9 and draw conclusions for needed future activity.

Task 4. After completion of the seminar the contract research agency will provide a copy of all seminar material, a summary of the seminar, and conclusions and recommendations drawn from the seminar as a result of the contract research agency's overall evaluations. Documentation of this task will constitute the final report.

STATUS OF RESEARCH

Research is complete. A Research Results Digest summarizing the research effort has been published and distributed. Copies of the agency final report are also available on request.

AMENDMENT(S) THIS REPORTING PERIOD: None

PROBABILITY OF SUCCESS: Good

REPORT(S) AVAILABILITY: NCTRP Research Results Digest 5, "Modular Approach to On-Board Automatic Data Collection Systems--Seminar," and copies of the agency final report for loan or purchase of xerox copies.

PRINCIPAL INVESTIGATOR(S): Mr. Lawrence E. Delbel
Associate Department Head
The MITRE Corporation
Metrek Division
1820 Dolley Madison Blvd
McLean, VA 22102
703/883-6910

RESPONSIBLE NCTRP STAFF ENGINEER: Crawford F. Jencks - 202//334-2379

AREA FORTY: IMPACT ANALYSIS

Project: 40-2, FY '82/'83
Title: Estimating Incremental Costs of Bus-Route Service Changes

Research Agency: Sydec, Inc.
Principal Investigator: Joseph R. Stowers

Effective Date: November 15, 1983
Completion Date: August 14, 1985
Revised Completion Date: February 28, 1987

AGENCY PERFORMANCE

1. Is the project on schedule? No* Percent project complete: 90
2. Is the research in keeping with the approved research plan? No*
3. Subcontract Amount: \$154,781
4. Estimated Expenditures to 12/31/86: \$145,000
5. Are the expenditures in keeping with the project progress? Yes

*Project is behind schedule because of delays in gaining transit agency participation in the testing, Task E. In the absence of UMTA funding for transit agencies to participate, it has been necessary to identify volunteers and to reduce the scope of testing. Further delays have occurred due to necessary reliance on transit agency testing and in the withdrawal of one transit agency.

PROJECT DESCRIPTION

In the face of continuing financial pressure on and within the transit industry it is increasingly important to allocate resources in the most effective manner. Accordingly, a better understanding of the cost changes accompanying both service expansions and reductions is required.

To this end, various costing techniques have been developed and used by transit agencies to estimate the incremental or extra transit costs that stem from either service reductions or increases. Thus far there is some doubt about the reliability, accuracy, and applicability of these techniques, especially with respect to bus route (as opposed to system) changes. As a consequence, there is a need to assess and validate available or improved techniques to provide simple, but more reliable and accurate, methods for estimating the incremental (or additional variable) costs stemming from service changes on bus routes.

The objective of this research is to develop simple, reliable procedures that permit transit agencies to estimate the incremental cost implications of various bus-route-service changes in a variety of operating environments (e.g., those of differing density, system size, and the like). In a broad context, it should provide a means for helping to address the question: If a specific service should be changed, what is the incremental change in cost? More specifically, it should provide procedures that identify the incremental short-run costs to transit agencies of changes in bus-route-service frequencies (seasonal, day of week, time of day), expanding, curtailing or eliminating routes, or changing periods of operation. The research should also build upon and extend previous cost-analysis studies.

The research approach will involve, but not necessarily be limited to, the following.

A. Identify and evaluate existing cost models (including those listed in the following citation: Booz-Allen Inc., "Bus Route Costing Procedures: A Review," UMTA Report No. IT-09-9014-81-1, May 1981. Available from the National Technical Information Service, Springfield, Va 22161, NTIS No. PB-82-105198, cost \$13.00).

B. Review/update current industry practice (this should consist of polling properties to determine the models (or rules of thumb) that they currently use).

C. Develop simplified incremental cost estimation procedures. Criteria suggested are:

Project 40-2 continued

1. Simplicity (emphasis should be on a reasonable level of accuracy with a limited number of variables, and be easy to compute and apply).
2. Minimization of data collection requirements.
3. Wide range application in terms of system size, type, route, and type of changes.
4. Easy update of the cost variables to reflect expected changes in component costs.
5. Design that facilitates the orientation of key staff (scheduling, maintenance, and others) to incremental costing methods.
6. Design that lends itself to intuitive interpretation of results so that it is easy to explain to decision-makers and is viewed as reflecting reality by transit staff.
7. Design that is disaggregate in nature so that it can be used to evaluate individual routes or frequency changes.
8. Consideration of the effects of fixed and variable costs, different management operating policies, different contract work rules, different service contracting procedures, and cost changes that occur both before and after rescheduling.

D. Prepare an interim report that summarizes the findings for review by the NCTRP.

E. Develop and implement a testing method for validating the proposed procedure(s) and comparing the results with those for existing procedures. Consideration should be given to existing procedures, such as the two-variable cost model (bus-hours and miles), the Adelaide model, the Booz-Allen model developed from the UMTA bus-route-costing study, and the procedure currently being used by the participating study agency. It is anticipated that the procedure will be tested at three transit agencies--a large agency (over 200 buses), a medium-sized agency (100 to 200 buses), and a small rural Section 18 agency (less than 100 buses). As a minimum the testing should address the following types of bus-service changes:

1. Effect of service changes at various times of day, days of week, and season.
2. Effect of route extensions or contractions.
3. Effect of route consolidations, additions, and deletions.
4. Effect of service frequency changes.
5. Effect of hours of service changes.

It is desirable that the incremental cost be measured both before and after run and driver assignments. Testing refinement should be done iteratively as appropriate.

F. Identify planning - policy implications and develop typical applications.

1. Show how procedures can help (a) assess service alternatives, including deficit/revenue implications; and (b) make strategic service change decisions.
2. Give sample prototypical applications of procedures.

G. Prepare a draft report for review by the NCTRP.

H. Revise the draft report and submit the final version in fulfillment of the technical obligations under the contract for the project.

STATUS OF RESEARCH

Tasks A through D have been completed and are documented in the Interim Report noted below. Important cost concepts and their relationship to costing problems faced by transit agencies have been defined. An overview of available models, including those developed as part of a recently completed UMTA-sponsored study, has been provided. The results of a survey of transit agencies, which was conducted for Task B, is presented. Among other things, the survey developed information on methods currently in use, problems with these methods, and suggestions for improvements. Simplified procedures have been developed as part of Task C. These include three procedures for estimating the effects of bus route service changes on driver costs and a fourth procedure for estimating non-driver incremental costs associated with service changes. Agency participation from the three agencies in Task E has been obtained with some difficulty inasmuch as intended UMTA funding for the agencies has not materialized. The number of testing situations (service changes) has been reduced from 60 to 20 in order to

Project 40-2 continued

match volunteered, transit-agency resources. Testing is complete at the three agencies. Tasks F and G are substantially complete with receipt of the preliminary draft final report anticipated at the end of the period.

AMENDMENT(S) THIS REPORTING PERIOD

<u>Date</u>	<u>No.</u>	<u>Type</u>	<u>Amounts and/or Dates (From/to)</u>	<u>Comments</u>
11/12/86	2	Time	10/30/86 - 2/28/87 (4 mos.)	See "Status of Research," for reasons completion date extended.

PROBABILITY OF SUCCESS: Good

REPORT(S) AVAILABILITY: "Estimating Incremental Costs of Bus-Route Service Changes" Interim Report developed in Task D. Available only on a loan basis from the Program Director, NCTRP.

PRINCIPAL INVESTIGATOR(S): Mr. Joseph R. Stowers
Sydec, Inc.
1601 Washington Plaza
Reston, VA 22090
703/435-7075

RESPONSIBLE NCTRP STAFF ENGINEER: Dan A. Rosen - 202/334-3231

AREA FORTY-SIX: GENERAL DESIGN

Project: 46-1, FY '82/'83
Title: Single Cable Communications Technology for Rail Transit Systems
Research Agency: Polytechnic Institute of New York
Principal Investigator: Dr. Frank A. Cassara
Effective Date: May 1, 1984
Completion Date: July 31, 1985
Revised Completion Date: September 30, 1985

AGENCY PERFORMANCE

1. Is the project on schedule? Yes Percent project complete: 100
2. Is the research in keeping with the approved research plan? Yes
3. Subcontract Amount: \$150,000
4. Estimated Expenditures to 12/31/86: \$150,000
5. Are the expenditures in keeping with the project progress? Yes

PROJECT DESCRIPTION

Rail-transit systems vary from those that have been in existence since the early 1900's to systems presently under design. These systems have typically used, or are planning the use of, multiple cables for the transmission of voice, data, and video information. The various cables provide for long-haul trunk facilities and access to local distribution networks. Additionally, the necessity for VHF or UHF-FM radio transmissions in underground portions of the system may require a separate radiating (or leaky) coaxial cable.

The large numbers of multipair and special-use cables used are expensive to install and maintain. A reduction in the number of cables needed for the communication requirements of transit systems can result in reduced acquisition, installation, and maintenance costs. The ultimate goal of this research is to replace all special-use cables with a single, multipurpose cable.

The objective of this research is to identify and develop recommended system parameters that will permit use of a single, multipurpose, wideband cable to support all rapid-transit communications requirements including, but not limited to: voice, data, video as well as VHF or UHF-FM two-way radio signals. For reliability, the single-cable concept should allow for a backup cable and cable span switching equipment. This research proposes a onsite-specific solution that considers retrofits and extensions to existing rail-transit systems as well as the requirements of new systems. Proposed solutions to the reduction in the number of cables should include consideration of coaxial cables, fiber optics, and other viable technologies. Any proposed solution must also take into account compatibility with existing communications equipment and systems, improved reliability and maintainability, reduced life-cycle costs, and system expansion (extension and spare capacity).

To accomplish the objective of this research, at least the following tasks are required:

Task 1. Survey the current communication systems and installation practices of rail-transit agencies to define the scope of the problem. (Some information on North American systems may be available at APTA.) Concurrently, survey the electronic industry for developments that offer potential solutions. Review the work of railroad, mining, and other industries that may be relevant to the problem and its solution.

Task 2. Establish the operational parameters that will be required for a single-cable communication system(s). Generate a range of technical characteristics that will define the nature of the proposed cable system(s) and its (their) configurations.

Task 3. Using the operational parameters and cable characteristics developed in Task 2, prepare design criteria to establish the technical and economic feasibility of the single-cable concept. Submit a fully documented feasibility study showing all alternatives studied and the recommended solution(s) for review and approval by the NCTRP. (Twenty (20) copies of the study report shall be submitted within 7 months after the

Project 46-1 continued

beginning date of the contract period. NCTRP approval will be required before the initiation of subsequent tasks. It is anticipated that the necessary review and approval will be completed within 2 months after receipt of report.)

Task 4. Using design criteria established in Task 3, prepare a system description in sufficient detail so that user agencies can prepare procurement specifications for specific applications. In addition, prepare a sample system design for a hypothetical 10-mile rail-transit system (5 miles underground and 5 miles on the surface) that includes basic equipment elements, local distribution networks, and its attendant costs.

Task 5. Prepare a draft report for review by the NCTRP.

Task 6. Revise the draft report and submit the final version in fulfillment of the technical obligations under the contract for the project.

STATUS OR RESEARCH

Research is complete and the agency's final report has been received. The primary recommendation for the single cable concept is a "closed loop fiber optic" system. If a rail transit system includes tunnels, a suggestion is made to place the optical fibers within the inner conductor of a leaky coaxial cable to also accommodate radio transmissions and, yet, maintain the single cable concept. A hypothetical system description and design are also provided.

PROBABILITY OF SUCCESS: Good

REPORT(S) AVAILABILITY: Publication of the final report in the NCTRP series is expected. However, only agency copies of the final report are available for loan or purchase, presently.

PRINCIPAL INVESTIGATOR(S): Dr. Frank A. Cassara
Polytechnic Institute of New York
333 Jay Street
Brooklyn, NY 12201
516/454-5075

RESPONSIBLE NCTRP STAFF ENGINEER: Crawford F. Jencks - 202/334-2379

AREA FORTY-EIGHT: SPECIFICATIONS, PROCEDURES, AND PRACTICES

Project: 48-1, FY '88
Title: Corrosion Attributed to DC Powered Transit Systems

Research Agency: IIT Research Institute
Principal Investigator: J. J. English

Effective Date: September 1, 1985
Completion Date: December 1, 1986
Revised Completion Date: March 31, 1987

AGENCY PERFORMANCE

1. Is the project on schedule? Yes Percent project complete: 92
2. Is the research in keeping with the approved research plan? Yes
3. Subcontract Amount: \$200,000
4. Estimated Expenditures to 12/31/86: \$175,000
5. Are the expenditures in keeping with the project progress? Yes

PROJECT DESCRIPTION

Structural damage to transit system properties and neighboring underground facilities due to corrosion caused by DC stray currents is a significant, persistent problem. Existing procedures and materials for prevention or mitigation are not sufficiently effective. The transit industry needs authoritative work that summarizes existing knowledge of damage caused by DC stray currents. Furthermore, there is a need to demonstrate the enormity of the problem and to design a research program that can provide cost-effective prevention and mitigation procedures.

The primary objectives of this research are to document and call attention to the severity of the corrosion problem caused by DC stray currents in terms of its economic, public safety, institutional and liability dimensions; to develop practical recommendations to transit agencies based on today's knowledge; and to design a research program to provide cost-effective solutions. Emphasis should be given to quantifying the dimensions to develop credibility. Furthermore, the research should stimulate coordination between key institutions involved in the DC stray current corrosion problem.

The following tasks are suggested:

Task 1 - Review, together with significant unpublished reports in rail transit agencies, published literature from both North America and abroad. Such a review should include literature concerned with stray current corrosion problems stemming back to the turn of the century for DC powered rail transit systems. Significant issues with respect to economics, public safety, institutions, and liability should be identified and priorities developed. From the review, elements of effective practice in such areas as track and structure construction, power system configuration, negative return and ground, and corrective methods to reduce stray current magnitudes should be identified and evaluated. Prepare a report synthesizing this information for use by transit agencies.

Task 2 - Conduct an indepth study of four transit agencies, and neighboring underground facilities, to document the severity of the problem in terms of economics, public safety, involved institutions, and liability. Furthermore, the study should identify agency practices to prevent or mitigate the problems. Consideration should be given to Boston, Chicago, Washington, and Toronto to provide a range of age and type of rail systems.

Task 3 - Integrate the results of Task 2 into the report developed in Task 1.

Task 4 - Develop a plan and conduct a workshop to serve the following purposes:

- a. Promulgation and review of the report.
- b. Development of practical recommendations to transit agencies.

Project 48-1 continued

- c. Development of a research action plan that reflects problems faced by neighboring institutions (such as utilities and agencies owning underground structures) affected by stray currents. Identify means and stimulate joint institutional support for such research. The plan should identify research projects and provide estimates of times and costs.

Task 5 - Prepare reports to serve the following purposes:

- a. To call to the attention of transit and business executives, governmental officials, and the media, the stray current corrosion problem.
- b. To present practical recommendations for improving transit industry practice for preventing and mitigating stray current corrosion.
- c. To provide an annotated bibliography defining areas of importance for important engineering references on the subject matter.
- d. To present the research action plan that identifies means for interagency coordination and institutional support together with the identification of research projects.

STATUS OF RESEARCH

The Task 4 workshop was successfully conducted on November 4-6, 1986 and a brief report on the results was prepared. The researchers are currently analyzing the data collected via the literature, the workshop, and other sources and are preparing the various research reports which will include a corrosion brochure, a summary of engineering practices, an annotated bibliography and the research action plan as mentioned under Task 5.d., above. All work will be completed during the next reporting period.

AMENDMENT(S) THIS REPORTING PERIOD

<u>Date</u>	<u>No.</u>	<u>Type</u>	<u>Amounts and/or Dates (From - To)</u>	<u>Comments</u>
11/17/86	2	Time	12/1/87 - 3/31/87 (4 mos.)	Additional time was requested to improve the quality of the final report.

PROBABILITY OF SUCCESS: Good

REPORT(S) AVAILABILITY: Agency Interim Report: "Literature Review Report," January 1986. Available on a loan basis from the Director, Cooperative Research Programs.

PRINCIPAL INVESTIGATOR(S): Mr. J. J. English
Senior Engineer
IIT Research Institute
10 West 35th Street
Chicago, IL 60616
312/567-4000

RESPONSIBLE NCTRP STAFF ENGINEER: Dan A. Rosen - 202/334-3231

AREA SIXTY: SPECIAL PROJECTS

Project: 60-1, FY '80 and continuing
Title: Synthesis of Information Related to Transit Problems

Research Agency: Transportation Research Board
Principal Investigator: Mr. Thomas L. Copas

Effective Date: November 7, 1980
Completion Date: Continuing

AGENCY PERFORMANCE

1. Is the project on schedule? Yes Percent project complete: *
2. Is the research in keeping with the approved research plan? Yes
3. Subcontract Amount: FY '84 \$200,000
4. Estimated Expenditures to 12/31/86: \$140,000
5. Are the expenditures in keeping with the project progress? Yes

*Project is carried out on a continuing basis with new topics being incorporated each year. See below for status of each topic.

PROJECT DESCRIPTION

Transit administrators, engineers, and researchers are continually faced with problems on which much information already exists either in documented form or in terms of undocumented experience and practice. Unfortunately this information is often fragmented, scattered, and unevaluated. As a consequence, full information on what has been learned about a problem is frequently not brought to bear on its solution. Costly research findings may be unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

In this project, particular transit problems, or sets of closely related problems, will be selected by the NCTRP Technical Steering Group as topics for information syntheses.

For each topic the objectives are:

1. To locate and assemble documented information.
2. To learn what practice has been used for solving or alleviating the problem.
3. To identify all ongoing research.
4. To learn what problems remain largely unsolved.
5. To organize, evaluate, synthesize, and document the useful information that is acquired.

STATUS OF RESEARCH

Thirteen synthesis topics have been referred to Project 60-1 during the first four years of NCTRP. Studies on the first eleven topics have been completed, and the remaining two are in various stages of progress. The operations and procedures of the synthesis program are summarized in NCTRP Research Results Digest 2, published in December 1984. The nine published syntheses of transit practice prepared under this project are listed in Table III of this progress report. Topic TS-6, "Traffic Control and Regulation at Transit Stops" (Synthesis 11) and Topic TS-13, "Bus Inspection Guidelines" (Synthesis 10,,), are in the editorial and publication process. The topics of concern and the status of each as of December 31, 1986, are:

Project 60-1 continued

TS-11 -- Transit Marketing: Successes and Failures

Topic Consultant: Richard L. Oram; New York, New York
 Effective Date: March 1, 1984
 Expiration Date: December 31, 1985

Many transit agencies have undertaken various marketing programs. The synthesis will study successful and unsuccessful aspects of these programs and will include the importance of marketing and the use of price, service, and promotion in marketing, with emphasis on promotion. The final draft of the synthesis is being reviewed by the Topic Panel and the Project Committee.

TS-12 -- Use of Incentives to Attain Specified Performance Standards in Collective Bargaining for Mass Transit

Topic Consultant: Darold T. Barnum; University of Illinois; Chicago, Illinois
 Effective: July 1, 1984
 Expiration: July 31, 1986

Some transit agencies have employee incentive programs that provide for awards based on attainment of specified performance standards. The synthesis will examine use of incentives as related to system performance, identify conditions and attitudes necessary for use of incentive programs, discuss results of these programs, identify techniques for developing and measuring incentive programs, and discuss how to analyze a system to see if an incentive program will work. The final draft of the synthesis is being reviewed by the Topic Panel and the Project Committee.

AMENDMENT(S) THIS REPORTING PERIOD

None--Continuing Project

PROBABILITY OF SUCCESS: High - Experienced investigators using a proven system ensure continued success.

REPORT(S) AVAILABILITY: See Table III

PRINCIPAL INVESTIGATOR(S): Mr. Thomas Copas
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 Transportation Research Board
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 2101 Constitution Avenue, N.W.
 Washington, DC 20418
 202/334-3242

RESPONSIBLE NCTRP STAFF ENGINEER: Harry A. Smith - 202/334-3236

HOW TO ORDER

Items for Sale

1. NCTRP Series Reports, Syntheses, and Research Results Digests (see Tables II and III for prices).
2. Research agencies' final reports (see project summaries for prices).
3. Microfiche (\$5.95 per report).
4. Other TRB publications.

A check or money order, payable to *Transportation Research Board*, must accompany orders totalling \$20.00 or less. Mail to:

Publications Office
Transportation Research Board
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

Items for Loan

1. Some research agencies' final reports, manuals, videotapes, etc., are identified in the project progress reports and are available on a loan basis upon written request to the NCTRP, 2101 Constitution Avenue, N.W., Washington, DC 20418.
2. Loan requests for films and tapes should be directed to:

TRB Audio-Visual Library
Transportation Research Board
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

Mailing and handling charges may be assessed, especially where 1st-class delivery is requested; an invoice will accompany the loaned item.

