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NATIONAL COOPERATIVE TRANSIT RESEARCH & DEVELOPMENT PROGRAM

SUMMARY OF PROGRESS  
THROUGH **1982**

IE TRANSPORTATION RESEARCH BOARD  
.92.5 ONAL RESEARCH COUNCIL  
N38 ONAL ACADEMY OF SCIENCES—NATIONAL ACADEMY OF ENGINEERING  
.982

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**SUMMARY OF PROGRESS  
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### NATIONAL COOPERATIVE TRANSIT RESEARCH & DEVELOPMENT PROGRAM

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. The client groups thereby 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, a private, nonprofit institution, as the Primary Technical Contractor (PTC) responsible for administrative and technical services, (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 Technology Development and Deployment, and (3) the Urban Consortium for

Technology Initiatives/Public Technology, Inc., responsible for providing the local government officials for the Technical Steering Group.

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 National Academy of Sciences for acceptance and administration through the Transportation Research Board.

The Board operates within the National Research Council, which serves both the National Academy of Sciences and the National Academy of Engineering, and is uniquely suited for the administrative role because: 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 governmental agencies, universities, and industry; it is recognized for its objectivity and understanding of modern research practices; its relationship to its parent organization 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 referred from UMTA are defined by panels of experts established by the Board 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 Academy, and administration and surveillance of the contract work are the responsibilities of the Academy and 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.

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## SUMMARY OF PROGRESS

### THROUGH 1982

#### INTRODUCTION

At the 1976 UMTA/APTA R&D Priorities Conference there was consensus among spokesmen for the Office of Management and Budget, Congress, and the transit industry that the Urban Mass Transportation Administration, U.S. Department of Transportation, should undertake a cooperative program of R&D to attack near-term problems in transit operations and equipment. This was the genesis of the National Cooperative Transit Research and Development Program (NCTRP) that got under way in November 1980 under the authority of Section 6(a) of the UMTA Act of 1964, as amended (49 U.S.C. 1605(a)). Thereby provided is a mechanism for addressing problems that impede operational effectiveness or productivity, but are not of the character to justify a centrally managed, Federally directed, R&D effort. This mechanism not only enables UMTA's principal client groups to join cooperatively in attempts to resolve near-term public transportation problems through applied research, development, testing, and evaluation, but it also provides them with a channel through which they can directly influence a limited portion of UMTA's annual activities in transit technology development and deployment. Consequently, the NCTRP's overall objectives are:

- To identify problems commonly agreed to be in need of R&D investigation and to establish a priority ordering among them.
- To provide an opportunity for many constituencies, including transit operators and local government officials, to identify problems and participate in developing solutions to them.
- To improve communication and technical information exchange.
- To provide a means of addressing near-term transit problems without requiring detailed, formal involvement of the Federal Government in the execution of R&D projects designed to provide solutions.

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, (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 Technology Development and Deployment, and (3) the Urban Consortium for Technology Initiatives/Public Technology, Inc., responsible for providing the local government officials for the Technical Steering Group.

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 National Academy of Sciences for acceptance and administration through the Transportation Research Board (refer to Figures 1 and 2). There, they are assigned to seven broad research fields under which panels or committees of experts are organized to deal with research in specific problem areas under the broad fields. They analyze the problems, outline particular projects and their objectives, and then prepare research project statements by which a wide solicitation is made for proposals from qualified private and public research agencies. They review the proposals, recommend contract awards on the basis of research plans offering the greatest probability of success, and provide counsel to the NCTRP staff responsible for surveillance of work under the research contracts. Finally, they review final reports for acceptability, decide if the reports evidence reasonable accomplishment by the agencies of the projects' research plans, and assist staff in determining the warrants for publishing the reports in a regular NCTRP series and distributing them through standing Board processes.

Panel membership is reported in the TRB Directory and includes persons from state and federal agencies, the UMTA client groups, universities, national associations, institutions with related interests, industry and other agencies. Members are appointed as individuals possessing expertise in specialized areas and not as representatives of the organizations by which they are employed. Because rarely is it possible to acquire members with the required knowledge and judgment who do not have technical biases, concerted attention is given to maintaining a balance of such biases. However, prejudicial biases, along with organizational and personal biases, are scrupulously avoided.

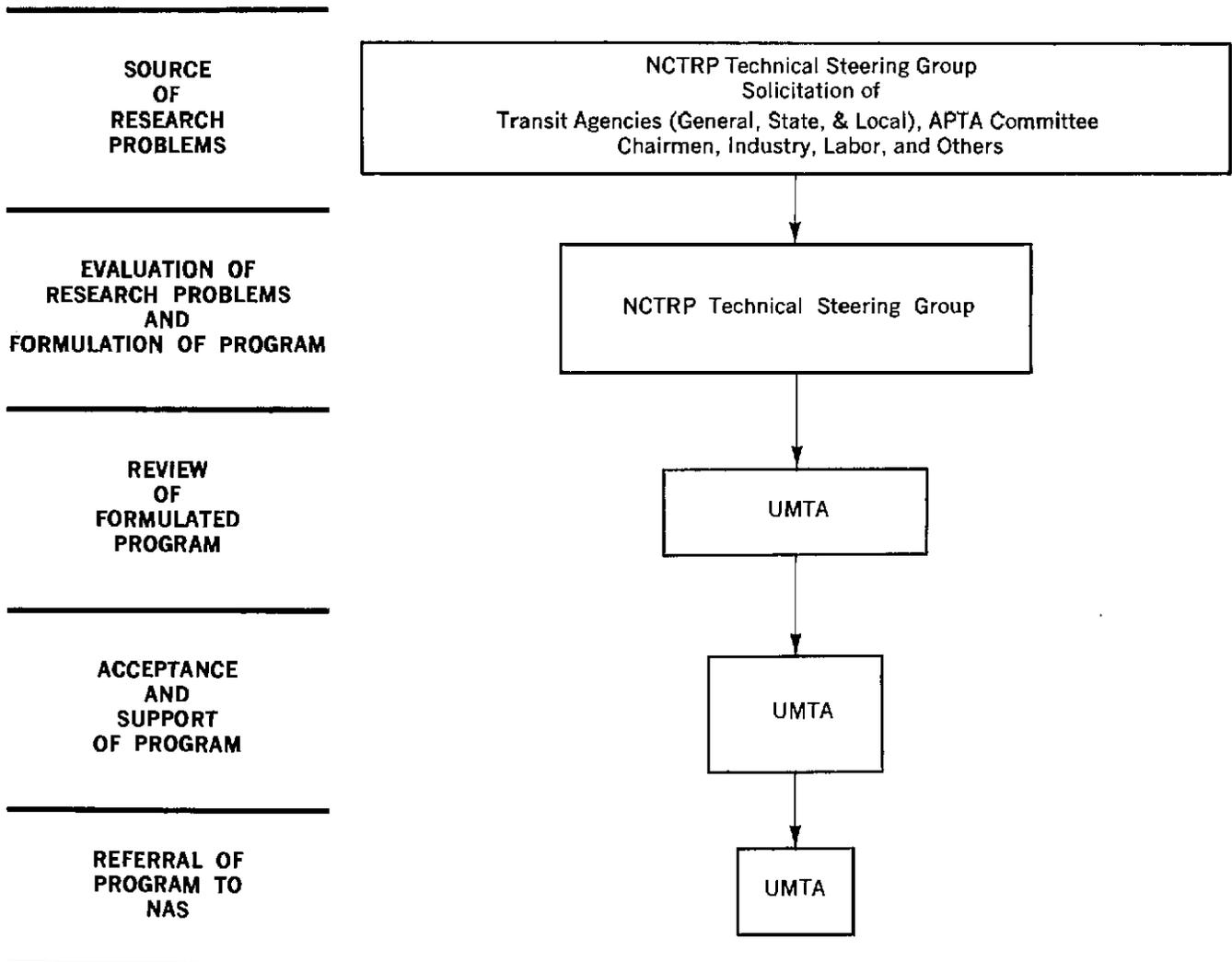
The Board's authority for administration of the Program rests with its Executive Committee from which is drawn the Subcommittee for the NCTRP, the body providing

counsel on all matters relating to policies and procedures for the planning and administration of the Program. The day-to-day activities are carried out by professional staff assigned by the Board. Projects engineers with broad experience in transportation research are responsible for administrative and technical surveillance of the contracts. In addition to reviewing quarterly progress reports and monthly progress schedules and maintaining telephone contacts, each engineer regularly visits his assigned projects throughout their contract periods. He discusses with each principal investigator the project's status to learn if the research is being pursued in line with the approved research plan. If necessary, frequent meetings involving the staff, panel, and agency personnel are held to review project

progress and provide guidance for continuing work. Finally, the projects engineer and the panel evaluate the completed research to determine the degree of technical compliance with the contract and the acceptability of the final report to the Board and the Academy.

The research findings are published in either of two regular NCTRP report series, and copies are formally distributed through the Transportation Research Board's selective distribution system.

Although research in the NCTRP is presently sponsored by UMTA, the administrative mechanism is applicable to other agencies' programs as well. However, the following description of how research is administered applies specifically to research sponsored by the UMTA.



**FIGURE 1**

Flow diagram for each program from initiation to referral by UMTA to the National Academy of Sciences

## PROGRAMS AND FINANCING

Two programs have thus far been referred to the Academy for administration, and a third is pending. Referred on November 7, 1980, was the FY 1980 program, the first. Totalling \$1,040,000, it consisted of eight problems ranging in funding from \$40,000 to \$300,000. Two of these were designated for TRB syntheses; the remaining six were scheduled for contract research (see Table 5 for status).

The FY 1981 program, totalling \$985,000, was formulated on October 7, 1981, by the Technical Steering Group and referred by UMTA to the Academy on March 30, 1982. It consists of eight problems ranging in funding from \$30,000 to \$300,000. Two of these were designated for TRB syntheses; the remaining six were scheduled for contract research (see Table 5 for status).

The FY 1982 program was developed on October 21 by the Technical Steering Group and forwarded on November 18 for UMTA approval. Pending at year's end for referral to the Academy at a total funding level of \$1,000,000 were two continuations of earlier projects and ten new projects, four of which are designated for TRB synthesis.

Funding to support all research to date is provided from UMTA's Section 6 funds for R&D activity. Although initiation of the NCTRP was accomplished solely with UMTA funds, the planning leading to inception of the Program envisioned that, given the multitude of problems facing them, UMTA's client groups would join ultimately in providing additional support, thereby enabling the Program to address a larger number of problems each year. Presently, the funds available to the NCTRP are sufficient to address but a fraction of the total need represented by problem submittals to the Technical Steering Group.

### HOW THE NCTRP IS ORGANIZED TO ADMINISTER RESEARCH PROGRAMS

In line with the Board's responsibility for administering the NCTRP, a TRB Executive Committee Subcommittee for the NCTRP considers all matters relating to policies and procedures required for the planning and administration of the Program. Members of the Executive Committee make up this committee.

In addition, the Board has established seven broad research fields under which project panels are organized to deal with research in specific problem areas under the broad fields (refer to Figure 3). For example, in the broad subject field of Operations, each project falling within the more specific subject area of Energy Efficiency—area 54—is assigned a panel comprised of outstanding individuals who are knowledgeable in the specifics of the particular project and who are looked to for technical guidance while research is in progress. Those projects that do not conveniently fit under one of the first six general fields are assigned to the seventh one, Special Projects.

Members of the project panels do not act as consultants or advisors to project investigators. Some 104 individuals serve without compensation on these project panels, and their total yearly contribution to the Program is an im-

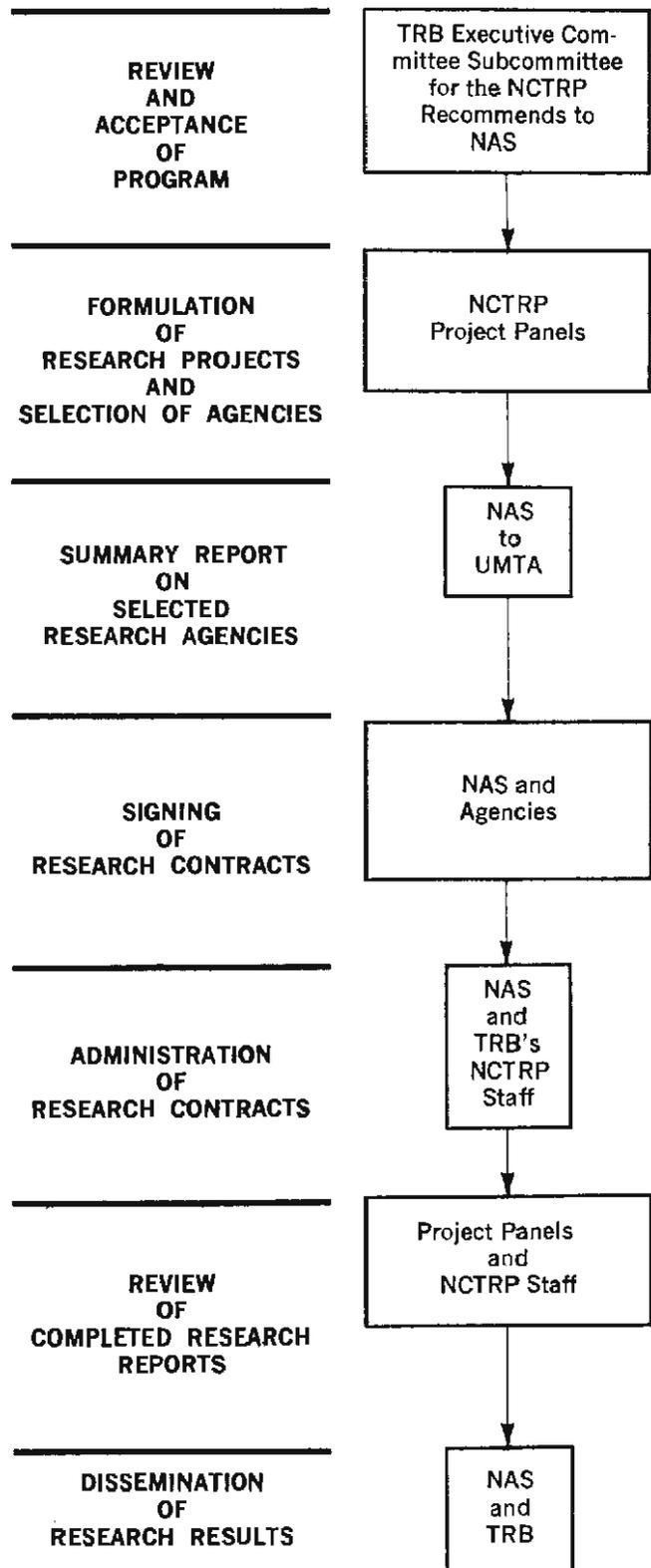


FIGURE 2

Flow Diagram for Each Program After Referral to the National Academy of Sciences

## NCTRP RESEARCH FIELDS AND AREAS

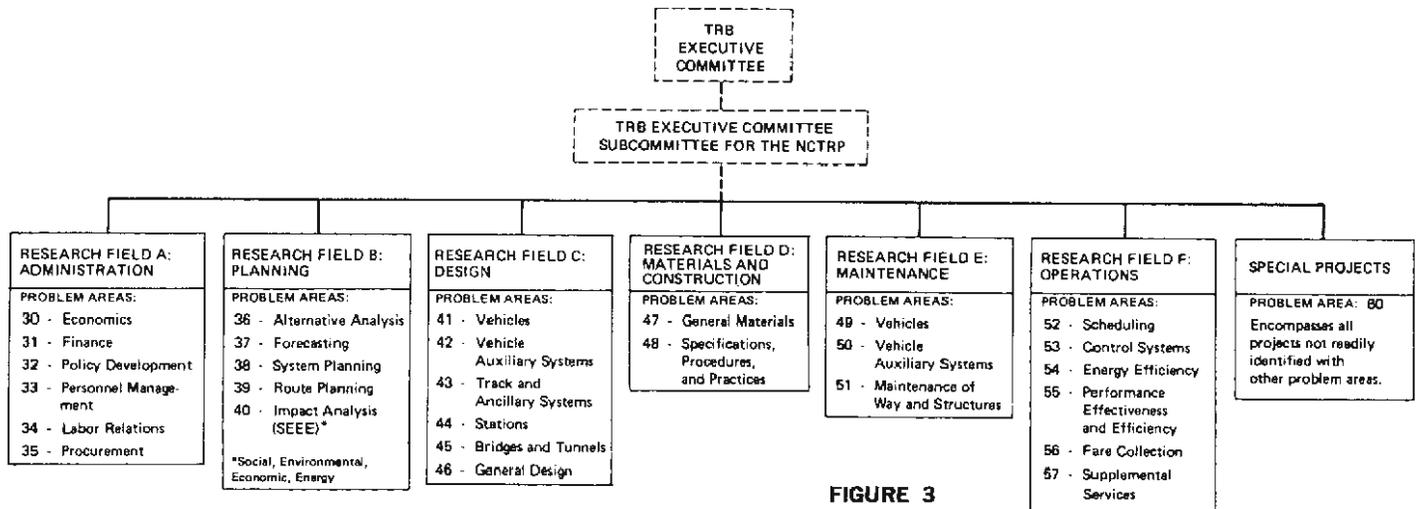


FIGURE 3

presently constitute 36 percent of panel membership. The duties and responsibilities of the membership include:

- Developing an operation plan geared to reaching the major problem area objective, including estimates of total cost and time to achieve the objectives.
- Drafting definite statements of objectives for projects within the problem area and within the funds allotted.
- Reviewing research proposals and making recommendations regarding selection of research agencies.
- Reviewing research progress.
- Providing guidance regarding technical aspects of the research.
- Reviewing and evaluating project reports as to the accomplishment of objectives and suitability for publication.
- Making recommendations as to whether or not studies of problems included in prior fiscal year programs should be continued.

Following the NCTRP staff review made after program referral to the Academy, the recommended program is referred to the TRB Executive Committee Subcommittee for the NCTRP for comments as to the critical need for the research, the availability of other suitable sponsors, and whether or not the research items are appropriate to be identified with the Academy. Unacceptable problems are returned by the Academy to UMTA with the reason for rejection and, when appropriate, with a recommendation for disposition.

#### HOW THE PROJECTS ARE PLACED UNDER CONTRACT

It is important to note that the NCTRP is not in the business of awarding grants for basic research. Rather, the Program calls for contract research with specific objectives that, if achieved, will result in solutions that are practical and readily usable. As the NCTRP officially gets each year's program under way, the project panels meet to write research project statements based on the research problems referred by UMTA.

These statements are then sent automatically to a mailing list of more than 3,000 interested individuals and research agencies. Because of deadlines the NCTRP must meet, proposals must be submitted according to fixed deadlines, and extensions simply cannot be granted.

In line with this process, submittals for the first two program years (FY '80 and FY '81) ranged from 8 to 25 per project, the average rate of return per project being 13 and 12, respectively (refer to Table 2). One agency submitted four proposals in one of the years; however, most agencies submitted only one each (refer to Table 3).

The types of agencies responding with proposals for the two programs are given in Table 4. The TRB, which through its Special Projects Division produces the NCTRP's synthesis of transit practice reports, is not included.

TABLE 1

#### DISTRIBUTION OF PROJECT PANEL COMMITTEE MEMBERSHIP WITH RESPECT TO AFFILIATION

AFFILIATION	NO. OF MEMBERS	POSITIONS INVOLVED
Transit Systems	37	39
State DOTs and Other Local Governmental Agencies	16	18
Urban Mass Transit Administration	13	13
Other Federal Agencies	3	3
Educational Institutions	8	9
Research Institutes	1	1
Industry, Consultants, and Trade Associations	12	12
Professional Societies and Service Organizations	2	2
TRB Liaison Representatives	6	11
All	98	108

TABLE 2  
NUMBER OF PROPOSALS SUBMITTED

ITEM	1981	1982*
No. of projects advertised	6	6
Proposals submitted	77	71
Proposals rec'd per project (ave.)	13	12

\* Calendar year

Projects making up the two programs are given in Table 5, and the types of agencies selected to carry out the projects are given in Table 6.

The opportunity to propose is open to anyone possessing extensive, demonstrated capability and experience in the problem areas in question; never are projects developed with the intent that they go to particular agencies. Because the projects are seeking practical remedies for pressing operational problems, it is expected that only the highest level of agency capability will be applied in meeting the commitments of the proposal—capability cannot be developed at project expense. Consonant with the goal of providing practical, readily usable solutions to pressing problems, there are fairly stringent specifications for proposals and agency attributes that are acceptable to the mission-oriented nature of the NCTRP.

The staff and panel members evaluate all proposals in a uniform manner, with primary consideration given to:

- The understanding of the problem and the merit of the research plan and approach.
- The experiment design and the promise of fulfilling the objectives of the project statement.
- The qualifications of the principal investigator(s).
- The adequacy of the facilities.

The proposed budget is not one of the primary factors because the funds available for research are given in the project statement. The budget does not enter the evaluation process leading to agency selection, except when specific items are reviewed to better determine manpower allocations. When the proposed cost exceeds the funds available, the proposal is rejected on receipt.

A panel meeting is held to select an agency, and a review is made of all known aspects of agency performance

TABLE 3  
NUMBER OF AGENCIES SUBMITTING  
ONE OR MORE RESEARCH PROPOSALS

NO. OF PROPOSALS SUBMITTED	NUMBER OF AGENCIES SUBMITTING PROPOSALS	
	1981	1982*
1	59	43
2	9	9
3	0	2
4	0	1
All	68	55

\* Calendar year

TABLE 4  
TYPES OF AGENCIES  
SUBMITTING PROPOSALS

TYPE OF AGENCY	NO. OF AGENCIES SUBMITTING	
	1981	1982*
Educational institutions	20	11
Research institutes	7	4
Industry, consultants, and trade associations	40	39
Professional societies and service organizations	0	0
State DOTs and other governmental agencies	1	1
All	68	55
No. of projects advertised	6	6

\* Calendar year

on other research projects under NCTRP or elsewhere. The successful proposals are retained by the panel members for use in monitoring the research. Proposals are considered to be privileged, and the information in them is not released outside of the Academy unless explicit approval is obtained from the agency. Policy also holds that panel notes, deliberations, etc., are privileged.

Following the selection meeting, a summary report on the recommended research agencies is sent to UMTA, and contract negotiations follow in due course, as does contract execution and commencement of research. Again, it should be emphasized that the NCTRP is a program of *contract* research—it does not operate on a grant basis. Further, proposals can be received only in response to advertised project statements, as the funds available each year to the Program are earmarked in their entirety for research problems specified by the sponsor—UMTA.

The policy of the NCTRP is to provide a debriefing to unsuccessful proposers. The initiative for obtaining a debriefing lies with the proposers and must be requested in writing. The debriefing is intended to indicate to the proposers the technical areas in which their proposals were judged weak and deficient and how the weaknesses or deficiencies were factors in their not having been selected. All debriefings are conducted in a scrupulously fair, objective, and impartial manner, and the information given the unsuccessful proposers is absolutely factual and consistent with the evaluations by the NCTRP panels. The factors constituting the basis for selection of the successful agency are identified, but the debriefing does not include a point-by-point comparison of all the elements considered in the evaluation criteria. Neither is there any revelation of confidential business information, trade secrets, techniques, or processes of the other proposers, nor is there any indication of the relative merits or technical standings of the unsuccessful proposers.

The Academy's research contract is either:

- Cost-Reimbursement (CR)

TABLE 5  
SUMMARY OF STATUS THROUGH DECEMBER 31, 1982, FOR FY '80 THROUGH FY '81 PROJECTS

PROJECT NO.	TITLE	RESEARCH AGENCY	COST (\$) CONTRAC AMOUNT CONTRAC
<b>AREA 30: ADMINISTRATION—ECONOMICS</b>			
30-1	Small Transit Buses: A Manual for Improved Purchasing, Use, and Maintenance	Arthur D. Little	\$299,378
<b>AREA 31: ADMINISTRATION—FINANCE</b>			
31-1	The Impacts of Federal Grant Requirements on Transit Agencies	Booz-Allen	50,000
<b>AREA 33: ADMINISTRATION—PERSONNEL MANAGEMENT</b>			
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
<b>AREA 36: PLANNING—ALTERNATIVE ANALYSIS</b>			
36-1	Improving Decision-Making for Major Urban Transit Investments	System Des. Concept	200,000
<b>AREA 38: PLANNING—SYSTEM PLANNING</b>			
38-1	National Transit Computer Software Directory	COMSIS Corp.	100,000
<b>AREA 39: PLANNING—ROUTE PLANNING</b>			
39-1	A Modular Approach to On-Board, Automatic Data Collection Systems	The MITRE Corp.	148,787
<b>AREA 40: PLANNING—IMPACT ANALYSIS</b>			
40-1	Simplified Guidelines for Evaluating Transit Options in Small Urban Areas	Barton-Aschman	149,960
<b>AREA 43: DESIGN—TRACK AND ANCILLARY SYSTEMS</b>			
43-1	Detection of Low-Level Fault Currents on Rail Transit Systems	Chas. T. Main, Inc.	99,953
<b>AREA 47: MATERIALS AND CONSTRUCTION—GENERAL MATERIALS</b>			
47-1	Improved Service Life of Urban Transit Coach Brakes	Battelle Mem Inst	300,000
<b>AREA 54: OPERATIONS—ENERGY EFFICIENCY</b>			
54-1	Improve Transit Bus Energy Efficiency and Productivity	Booz-Allen	39,976
54-2	Energy Management of Electric Rail Transit Systems	Carnegie-Mellon	135,115
<b>AREA 60: SPECIAL PROJECTS</b>			
60-1	Synthesis of Information Related to Transit Problems	TRB	210,000
	TS-1: Cleaning Equipment and Procedures for Transit Buses	ATE Mgmt	75,000
	TS-2: Priority Treatment for Buses on Urban Streets	PAWA	75,000
	TS-3: Effects of Fuel Additives and Alternative Fuel Grades for Transit Buses	—	30,000
	TS-4: Guidelines for Allocation of Time for Transit Coach Maintenance Functions	—	30,000

<sup>a</sup> Continuing activity supported in FY '80 and FY '81 total amount shown.  
<sup>b</sup> Allocated—Balances are carried forward to support future synthesis studies.

TABLE 6  
PUBLISHED REPORTS OF THE NATIONAL COOPERATIVE TRANSIT RESEARCH & DEVELOPMENT PROGRAM

Rep. No.	Title, Project, Pages, Price
1	Transit Bus Energy Efficiency and Productivity—Bus Equipment Selection Handbook (Project 54-1), 55 p., \$7.20.
<b>Synthesis of Highway Practice</b>	
Rep. 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

	COMPLETION DATE	PROJECT STATUS (for details, see latest Summary of Progress)	PROJECT NO.
/82	7/31/84	Research in progress	30-1
/81	10/31/82	Completed—Published as NCTRP Report 2	31-1
/81	10/14/83	Research in progress	33-1
/82	10/31/83	Research in progress	33-2
/81	7/1/83	Research in progress	36-1
/82	11/30/83	Research in progress	38-1
/82	4/30/84	Research in progress	39-1
/82	1/24/84	Research in progress	40-1
/82	2/14/84	Research in progress	43-1
/81	11/30/83	Research in progress	47-1
/81	6/30/82	Completed—Published as NCTRP Report 1	54-1
/81	3/31/83	Research in progress	54-2
/80	a	Research in progress	60-1
/81	12/31/81	Completed—Published as NCTRP Synthesis 1	(TS-1) 60-1
/81	12/31/81	Completed—Published as NCTRP Synthesis 2	(TS-2) 60-1
/82	9/30/83	Research in progress	(TS-3) 60-1
/82	10/31/83	Research in progress	(TS-4) 60-1

JE 7  
 NCTRP RESEARCH RESULTS DIGESTS \*

DIGEST NO.	PROJ. NO.	TITLE, PAGES, PRICE
	33-1	Review of Literature Related to Bus Operator Stress, 15p, \$3.00

\* Table 5 for project titles. Orders must be prepaid if for less than \$10.00. Make request to Publications Office, Transportation Research Board, Constitution Avenue NW, Washington, DC 20418.

**TABLE 6**  
**AGENCY DISTRIBUTION OF FY '80 & FY '81**  
**PROJECTS**

TYPE OF AGENCY	PROJECTS AND CONTINUATIONS	
	NO.	%
Educational institutions	1	8
Research institutes	1	8
Industry, consultants, and trade associations	10	84
Professional societies and service organizations	0	0
State DOTs and other governmental agencies	0	0
All	12	100

- Cost-Reimbursement Plus Fixed Fee (CRPFF)
- Fixed Price (FP)

The research agency's proposal is made a part of the contract with the Academy. Thus, in addition to the specific research objectives outlined in the contract, the research agency's cost estimates are also recognized as being part of the agreement. However, the principal investigator does have flexibility in conducting the research, if it is consistent with the general scheme of the proposal.

#### KEEPING TRACK OF RESEARCH IN PROGRESS

A professional staff is assigned to NCTRP by the Board. Currently, five project engineers with wide-ranging expertise are responsible for administrative and technical surveillance of the contracts. In addition to reviewing quarterly progress reports and monthly progress schedules, and maintaining telephone contacts, each engineer visits his assigned research agencies throughout their contract periods. He discusses with each principal investigator his project's status to learn if the research is being pursued in line with the approved research plan. Finally, the engineer and cognizant project panel evaluate the completed research to determine the degree of technical compliance with the contract.

#### SYSTEMATIC PLANNING FOR GETTING RESEARCH RESULTS FROM NCTRP PROJECTS INTO PRACTICE

##### Promoting Useful Results

Previous narrative substantiates the fact that many activities take place between initiation of research programs and execution of research contracts. Many additional ones take place before formal publication of the final report is realized. At the milestones of the process network reflecting all activities, NCTRP concentrates on the opportunities to increase the odds for acquiring useful research results and to increase the probability that useful results will find their way into practice more quickly. Beyond the sponsor's first weighting of the odds by setting the goals for a program of applied research dedicated to solving pressing op-

erational problems, the NCTRP tries to further weight the odds favorably by:

- Establishing the agency and personnel qualifications that are mandatory if the goals are to be achieved. Emphasis is placed on the importance of a record of successful past performance in endeavors similar to those to be undertaken. Further, it is also stipulated that proposals are not acceptable if they do not contain specific statements as to how the contemplated results can be used to improve practice.

- Utilizing persons who are not only experts in the particular problems area but who also have a complete understanding of the needs of the practitioners to define the research problem and its objectives in the form of a precise project statement on which fully responsive research proposals can be based. Experts drawn from transit agencies play a major role in this task.

- Exercising extreme care in the process of selecting research agencies to ensure not only that the proposed research plan is the best possible in addressing the specifics of the objectives but that it also culminates in the best promise for providing the practitioner with a product that is both usable and readily implementable.

- Establishing—on the basis of staff and project panel review of and suggested modifications to the research plan—a clear meeting of the minds as to what specifically is expected from the research and the personnel carrying it out in order to meet the needs of practitioners.

- Acquiring an amplified research plan that is intended to detail comprehensively the approved research plan and to include 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 and by the project panel as required.

- Carrying out project surveillance sufficient to keeping the research in line with the approved research plan, constantly keeping the researchers aware of the needs of practitioners, and insuring that all project developments through final reporting center around these needs.

- Requiring research reports in a format that is designed specifically to ease the burden of the busy practitioners in assimilating what has resulted from the research and how it can be used. Different treatment is given to the material that would be of interest to other researchers.

#### NCTRP Reporting of Research Results

In an applied research program such as the NCTRP, the sponsor rightfully expects not only results that are accurate but also findings that can be readily put into practice. This means that the final research reports must be presented in language understandable to practitioners and in such format as to permit easy assimilation. Too many of today's research reports are frequently so clouded by obscure language and format that the reader must spend precious time and effort in translating them into concise and readily usable working documents.

Research agencies for the NCTRP are required to report their results in a form that succinctly summarizes the find-

ings and likewise informs the reader of the application of the findings. These 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 in appendices and do not have to be labored through to extract the findings. The Program specifies style and organization of all reports to guide the researcher in his writing to provide a document of maximum use by the sponsors and others.

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 in either of the two regular NCTRP series (Reports or Syntheses of Transit Practice) 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 in the NCTRP series, each report or synthesis is distributed immediately through the Transportation Research Board's selective distribution system. Copies go automatically to about 100 libraries, Board transit representatives, educational institutions, liaison representatives, appropriate panels and committees of the Board, and individual members who have selected publications in the particular subject area of the report. Special distribution lists are developed as appropriate to ensure receipt by all segments of the operating agencies of information helpful to their operations. As a further means of disseminating the research reports, announcements of their availability are made to the trade press. Each of these reports 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. Also, during the conduct of the work, periodic progress reports are prepared by the staff and sent to UMTA as a measure of providing a current awareness of on-going work. In addition, the Board's Technical Activities Staff personnel follow the progress of the work throughout its conduct and consequently are able, in their activities, to discuss application of the research results with those best able to use them. Research findings not published in the NCTRP series are stored on microfiche by the Academy. On an interim basis, the findings are sometimes reported in a *Research Results Digest*, described next.

The *NCTRP Research Results Digest* series—flyers published at frequent intervals—is a means for providing practitioners with an early awareness of the research results emanating from NCTRP projects. By making results known as they are developed and prior to publication of the final reports in the regular NCTRP series, it is hoped that their early use in practice will be encouraged. For the most part, each Digest is intended to be very brief in summarizing specific findings—they do not deal with research methodology—and require the reader to expend very little time in determining how the

research results may be of use to him. The basic format is couched in terms of the problem and the solution to it, the findings, and applications. Practitioners should find them of direct assistance in serving the intermediary, or interpretive, position between research and operating personnel, for each Digest speaks directly to the vital factors of:

- Whether the research stands alone or whether it has to be combined with results from other research in order to be useful.
- Whether the results are defined explicitly enough to permit direct application to practice.
- Whether the results have to be translated into the working tools with which the practitioner is familiar.
- Whether the research findings have been evaluated sufficiently to make some reasonable determination of the probability of their success when applied to practice.

#### IMPLEMENTING RESEARCH RESULTS

Emphasis has been given in the foregoing to the devices employed to obtain solutions that are directly applicable to practice. Because the NCTRP process does not include an implementation activity, the initiatives for incorporating the solutions in practice must be taken by the UMTA and transit agencies. To this end, the Program's final concentration is on the reporting of research findings in one or more of the variety of publications described earlier and, as will be done in future annual reports, providing whatever details are available on the experiences of the States and transit agencies in using the products from NCTRP research. With this objective, the Program will be grateful for any information on actual application of results and associated benefits. Because the research addresses critical, national problems, the assumption is that documented use and payoff to any one agency should attract others to give the results a try in whatever degree they see fit. Only if the results get around and are used can it be said that UMTA truly is capitalizing on its investment. Otherwise, projects that were highly successful might just as well have been failures; the end result is the same—the money will have been spent in vain.

#### SUMMARY

The National Cooperative Transit Research and Development Program is a unique contract research effort designed to respond quickly and efficiently to the needs of UMTA and the transit industry through solution of near-term public transportation problems. Although the Transportation Research Board administers the Program, the research content is solely the prerogative of the Urban Mass Transportation Administration. The Program is one of applied (rather than basic) research, and every possible effort is made to help administrators and engineers put the findings to early use. Program policy ensures maximum exposure of the research while in progress in the hope that research results will, in fact, more quickly find their way into practice in the form of policies, procedures, specifications, and standards of the operating agencies.

## PROGRESS BY PROJECT

Only those areas are listed in which there are active projects. For a complete list of project areas, refer to Figure 3.

### AREA 30: ECONOMICS

Project 30-1 FY '81

#### Small Transit Buses: A Manual for Improved Purchasing, Use, and Maintenance

*Research Agency:* Arthur D. Little, Inc.  
*Principal Invest.:*  
*Effective Date:* November 1, 1982  
*Completion Date:* July 31, 1984  
*Funds:* \$300,000

One of the important decisions facing both rural and urban transit decision-makers 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:

*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.

## AREA 31: FINANCE

Project 31-1 FY '80

### The Impacts of Federal Grant Requirements on Transit Agencies

*Research Agency:* Booz, Allen & Hamilton, Inc.  
*Principal Invest.:* Subhash R. Mundle  
*Effective Date:* November 30, 1981  
*Completion Date:* October 31, 1982  
*Funds:* \$50,000

As the federal transit program has grown, this growth has been accompanied by a proliferation of federally imposed requirements. The costs and effects of grant requirements are causing increasing concern to transit agencies.

The general objective of this study was to determine the costs and effects of federal legislation, regulations, UMTA circulars, administrative letters and formal administrative guidelines for the Section 3 capital grant application process and to make recommendations for its improvement. The study results are useful to (1) transit agencies in their decision to apply for federal grants, (2) legislators drafting legislation, and (3) the Urban Mass Transportation Administration in amending requirements.

Because of the limitation on available funds, the research specifically excluded consideration of Section 13(c) and 504 requirements. Additionally, the research did not consider Section 5 capital and operating grants; applicability to fixed guideway systems; project management requirements for approved grants; and applicability to specialized transit services.

The study results show that an application for a Section 3 grant requires from 20 to 30 exhibits of supportive documentation and assurances. The origin of these requirements can be traced to the Urban Mass Transportation Act and UMTA promulgated regulations and administrative policies. Requirements vary primarily by project type, rather than by amount of funding request or urban area size. Impacts of compliance include: direct levels of effort; delays in project implementation, inflationary cost escalation and loss of management flexibility. The magnitude and extent of these impacts vary significantly among transit agencies. Reasons for the differences are attributable to factors both within and beyond the control of the applicant agency.

By 1981 the transit industry viewed application procedures as routine. The assignment of a permanent grants function within local agencies has reduced preparation

costs. In addition UMTA relaxed several of its reporting requirements. Yet areas for improvement remain. The most significant of these include the need for consolidated guidelines; the need for a streamlined application document; and the need for coordinated local, state, and federal capital programming efforts.

The study results have been published as:

NCTRP Report 2, "The Impacts of Federal Grant Requirements on Transit Agencies."

## AREA 33: PERSONNEL MANAGEMENT

Project 33-1 FY '80

### Transit Bus Operator Selection and Training for Dealing With Stress

*Research Agency:* Group Associated Management Services, Inc.  
*Principal Invest.:* Dr. Brownlee Elliott  
*Effective Date:* October 15, 1981  
*Completion Date:* October 14, 1983  
*Funds:* \$150,000

Some bus operators possessing the basic skills to operate the vehicle may still experience difficulties in performing their job satisfactorily because of inability to cope effectively with the public. Use of all possible training and disciplinary action does not help when the individual hired does not have the psychological strengths necessary to deal effectively with continuous public contact, and the resultant stress may lead to more workers' compensation claims for nonvisible physical injury (i.e., heart and psychological problems) as well as to more accidents, absenteeism, and personnel turnover.

Various selection and training methods are currently being used by individual transit agencies. Some of these methods have been developed specifically for application in the transit industry, some have evolved from practice within individual agencies, and others represent modifications to methods originally developed for agencies outside of the transit industry. At present, however, no single method of selecting or training bus operators from the viewpoint of their ability to deal with stress is considered to be generally acceptable for wide application by transit agencies. To ensure that methods have general applicability, the range of needs and capabilities of different size transit agencies, regional differences, and the makeup of the bus operator population (i.e., male/female and minorities) must be fully considered.

The objective of this research is to provide an evaluative device or questionnaire for use as part of the bus-driver-selection process that will validly indicate the applicant's susceptibility to stress which is likely to affect job performance. The research will also provide two training modules: one designed to help newly hired operators anticipate and deal with typical stressful situations, and one designed to help supervisors recognize stress symptoms displayed by operators and provide guidance on appropriate courses of action.

Reference literature and existing training programs have been reviewed to identify the various environmental, psychological, and physiological factors commonly used in stress analysis. NCTRP Research Results Digest 1 provides a summary of the literature review. A preliminary set of factors and characteristics relevant to the bus operators' job has been prepared by the researchers and reviewed by managers, operators, and labor representatives from selected transit agencies for suggested additions and deletions. Agencies participating in this review included the Detroit Department of Transportation, Kansas City Area Transportation Authority, Regional Transit Service (Rochester, NY), Mercer County Metro (Trenton, NJ), Oklahoma City Mass Transit and Colorado Transit Management (Colorado Springs, CO).

Existing operator-selection-test mechanisms have been evaluated for general applicability in measuring an individual's tolerance for stress. An existing device will be modified or a new test device will be developed to bring together current efforts dealing with the effects of stress. This device will have wide applicability in the transit industry and will be primarily aimed at screening new applicants. The device will treat stress factors individually and in groups such as passenger contact, environment, management/union/employee relations, personal problems, and equipment. Field tests will be conducted by operators from selected transit agencies.

Two sample training modules will also be prepared: one for newly hired operator training (and perhaps for voluntary retraining) and one for supervisor training. The primary focus of the new operator training will be to alert the driver to typical stress-causing situations and to provide specific guidance on how to cope with each situation. Typical situations include (1) passenger contacts, e.g., fights on the bus; (2) environmental factors, e.g., bad weather; (3) management/union/employee relations; (4) personal problems, and (5) equipment. The supervisor's training module will focus on the recognition of stress symptoms and tendencies (resulting from personal or job-related causes) and on the identification of appropriate courses of action. Both modules will be adaptable by an individual transit agency so that through property-specific modifications they can be made part of existing training programs.

A listing will be provided of pertinent data and resources (films, videotapes, surveys, models, books, papers, etc.) identifying concomitant costs, sources, and transit agencies that are using such methods for selection and stress management training of bus operators and supervisors.

**Project 33-2** FY '81

### **Assessment of Job Enrichment Programs for the Transit Industry**

*Research Agency:* Public Administration Service  
*Principal Invest.:* Dr. Susan G. Clark  
*Effective Date:* November 1, 1982  
*Completion Date:* October 31, 1983  
*Funds:* \$97,821

The political and fiscal environment of transit agencies

is in a period of significant change. Scarcity of funds will mean a renewed emphasis on productivity and redoubled efforts to retain and motivate quality employees in the absence of financial incentives. New federal policies stressing local initiative will encourage management to be more sensitive to innovative ideas, and a changing work force will make different demands.

Although the transit industry is highly labor-intensive, a great deal of emphasis has been placed in the past on capital development, financial controls, and transportation planning. Potentially, one of the most important areas for improving transit agency effectiveness is the development and management of human resources through job enrichment programs. There is a need for a systematic investigation of the feasibility of job enrichment programs, such as job restructuring, quality circles, and other techniques that utilize the full talents and abilities of transit employees. It is anticipated that the greatest benefits of job enrichment efforts could be derived from first-line supervisors and those they supervise.

For purposes of this study, job enrichment will be defined as making the elements of the job both physically and psychologically more stimulating, resulting in more productive behavior. The organization could thus provide an environment that allows and influences self-esteem and promotes a positive attitude about one's employment through an individual's own initiatives. Job enrichment offers several possible benefits to the transit industry. For the organization, it provides the prospect of improving the operating environment by enhancing the effective management of human resources. For the individual employee, the concept fosters greater job satisfaction, improved self-esteem, and higher productivity.

The general objective of this research is to assess the feasibility of job enrichment programs for the transit industry for first-line supervisors and those they supervise. The assessment would include a survey and analysis of current techniques used to improve job satisfaction and productivity in transit as well as other fields with similar characteristics. The assessment would identify common barriers to the implementation of job enrichment programs in transit agencies including, but not limited to, cost, labor-management relationships, political climate, and resistance to change. The assessment would also include specific methods for measuring, monitoring, and evaluating the effectiveness and cost benefit of job enrichment programs. These objectives will involve the following tasks:

*Task 1.* Review of job enrichment literature.

*Task 2.* Inventory and assessment of current status of job enrichment in transit.

*Task 3.* Select and evaluate, for application, at least 5 job enrichment techniques from Tasks 1 and 2. The evaluation will include an assessment of the feasibility of these techniques when applied to different size properties (small, 50 buses or less; medium, 51 to 200 buses; and large, over 200 buses).

*Task 4.* Develop sample detailed job enrichment programs for bus and rail operators, mechanics, first line supervisors, and one other support position.

*Task 5.* Develop strategy for dissemination to the industry of job enrichment programs.

*Task 6.* Prepare final report that also contains an appendix that catalogs specific job enrichment techniques applicable to the transit industry.

## AREA 36: ALTERNATIVE ANALYSIS

**Project 36-1** FY '80

### Improving Decision-Making for Major Urban Transit Investments

*Research Agency:* System Design Concepts, Inc.  
*Principal Invest.:* Joseph R. Stowers  
*Effective Date:* November 2, 1981  
*Completion Date:* July 1, 1983  
*Funds:* \$200,000

The environment for transportation planning and investment decisions is in a period of dramatic change. Fiscal constraints, a possible reorientation of federal transportation policies, and an increasing reliance on local commitment and decision-making are all likely to influence significantly the future of transportation in urban areas. Even with these pressures, however, urban areas will still be facing decisions on major investments in transit systems. Thus, there will be a need in future years for a planning and analysis process which examines major transportation options and which informs decision-makers so that most cost-effective investment decisions can be effected.

Since 1975, the Urban Mass Transportation Administration has required, as a condition for federal funding support, a structured process termed alternatives analysis for proposed major investments in urban mass transit facilities. This process is used to identify priority corridors for possible major investments and to assess the cost-effectiveness of these investments in comparison to less costly transit improvements. Information generated in the process is used both by federal officials in administering a discretionary capital grant program and by state and local officials in determining priorities and identifying needed improvements in mass transportation services. Three important decision points occur within the UMTA major transit investment planning process. First, appropriate local officials identify the corridor(s) where major investments appear to be most needed. Second, local and federal officials agree on a small set of investment alternatives that encompass a reasonably broad range of options. Finally, local, state, and federal officials agree on one (or more) of these alternatives for advancement into preliminary engineering.

Since the advent of the alternatives analysis requirement, a significant number of urban areas have been involved in some aspect of the process. Concerns have been expressed with the process. For example, there is uncertainty regarding both the effect on the timing of transit investment decisions and the use of information in the federal review process and in local decision-making. Although adjust-

ments to the process have been made to enhance its usefulness in local, state, and federal decision-making, no comprehensive assessment has been made of the degree to which the analytical requirements have provided appropriate information at key decision points.

There is a need to evaluate past experience with alternatives analysis and to recommend improvements in the process that will result in more effective local, state, and federal decision-making. Such an assessment would be useful, for example, in identifying points where decision-makers have not had complete information, where the process has constrained appropriate decisions, or where significant efforts are invested in the development of information that is not used in decision-making. Although it is unclear what direction federal policy will take in regard to alternatives analysis, the need for some form of alternatives analysis for such investments will continue.

The general objective of this research is to assess the federal, state, and local decision-making process for major urban mass transportation investments by evaluating recent alternatives analysis experiences. The purpose of the assessment is to identify potential improvements in policy, procedures, and use of technical information; and to formulate planning procedures recommendations for use by federal, state, and local agencies. Such improvements would be in terms of time, cost, scale, presentation of information, role of participants, and the like. (The assessment is not intended to prescribe specific analytical techniques or to judge the appropriateness of previous major urban transit decisions.) It is anticipated that research tasks to satisfy the general objective will consider, but will not be limited to, the following tasks:

*Task 1.* Inventory all applicable regulations and requirements concerning the evaluation of proposed major urban mass transportation investments.

*Task 2.* Review relevant literature on alternatives analysis and transit investment decision-making.

*Task 3.* Prepare methodologies for (a) the analysis and assessment of recent alternatives analysis decision-making experiences and (b) the selection of case studies.

*Task 4.* Select and conduct case studies, including those undertaken pursuant to the 1976 guidelines as well as other cases.

*Task 5.* Evaluate the usefulness of information developed in alternatives analysis for decision-making at each level of government.

*Task 6.* Formulate recommendations to Federal DOT and to state and local agencies.

Tasks 1 through 4 have been completed as of December 31, 1982. During the course of the project the number of case studies was increased in order to develop a better basis for the formulation of recommendations. Tasks 5 and 6 are in progress.

## AREA 38: SYSTEM PLANNING

Project 38-1 FY '81

### National Transit Computer Software Directory

*Research Agency:* COMSIS Corporation  
*Principal Invest.:* David M. Levinsohn  
*Effective Date:* December 1, 1982  
*Completion Date:* November 30, 1983  
*Funds:* \$100,000

Over the past decade, computer (software) systems have gained widespread acceptance as important management and operating tools in public transit agencies. Representative software applications include planning (UTPS), scheduling (RUCUS), operations control, maintenance (SIMS), finance, and personnel. It is estimated that the public transit industry spends several million dollars each year on the design of software. Because there are great similarities in the structure and operation of transit agencies, software developed by one agency can often be adapted for use by other agencies with much less cost and effort than custom-designing completely new software. The lack of knowledge of existing software and its applications results in the spending of significant amounts of money by many transit agencies to develop new software that may not be as effective as it could be or may be "reinventing the wheel." Therefore, there is a need for the design and implementation of a detailed and complete national transit computer software directory that can be continuously updated to function as a central clearinghouse, making information available to individual public transit agencies that are planning software development. The anticipated benefit from the design and implementation of the directory is lower costs for software users. Use of the directory should lead directly to commonality of systems, faster software implementation, and public domain software that can be obtained at minimal cost. The benefit of identifying and using transportable software can only be realized if there are provisions for maintenance of the directory on a continuing basis.

The objective of this research is to develop and pilot test a methodology for the establishment and continuous updating of an automated directory of computer software useful to the public transit industry. The directory will have the capability of including (1) software suitable for use by transit agencies of all sizes, and (2) existing and future software for use on computers of all types and sizes.

To accomplish the objective, the following tasks are to be conducted:

*Task 1—Directory Content.* Review and cite the applicable literature describing the availability of computer software programs for use by public transit agencies. Examples of such references include, but are not limited to, the American Public Transit Association (APTA) "Catalog of Management Information System Applications within the Transit Industry," the American Association of State Highway and Transportation Officials (AASHTO) "Computer System Index," and work of the Institution of Trans-

portation Engineers (ITE). Using these references, and in consultation with the transit industry as appropriate, the researchers will propose content, structure, and format for a directory of computer software. The content of the directory will focus on the principal categories of transit operation, such as finance, operations, maintenance, administration, planning, as well as others deemed appropriate.

*Task 2—Methodology.* The researchers will investigate existing information systems, such as the Transportation Research Information System (TRIS), the International Road Research Documentation, and others, to evaluate their capabilities regarding the recommended directory as part of those existing systems. The researchers will review and evaluate other methods of designing and maintaining the automated transit directory. This evaluation should include:

- Description of methods reviewed.
- Review criteria used.
- Pros/cons of each method.
- Recommended method.

*Task 3—Management Procedures.* The ultimate success of this project requires the existence of an organization (not yet identified) that will be responsible for the provision and maintenance of an up-to-date directory. The researchers will define the management function required of this organization. This function will be based on a thorough examination of existing software directories and their deficiencies. The management function should assure that the system will serve the need of both large and small transit agencies.

*Task 4—Case Study.* As a means of demonstrating the capabilities of the proposed methodology, the researchers will provide an updated "1980 APTA Catalog of Management Information Systems Applications within the Transit Industry." This catalog is to be provided in both hardcopy and machine-readable format. It should contain all of the data elements as defined in Task 1.

*Task 5—Directory Maintenance.* Evaluate and recommend potential organizations that can provide the management functions as described in Task 3.

Consideration must be given to the following issues:

- How and by whom should the directory be maintained?
- How should directory information be disseminated?
- What will be the estimated cost of this function?
- What permanent funding sources are recommended?

Because the ultimate selection of the organization to maintain the directory will depend on these issues, a complete discussion should be provided, particularly with respect to recommending funding sources; including consideration of applicable laws, regulations, policies, and institutional inter-relationships.

Research is under way on Task 1 of the study involving the collection and review of applicable literature.

## AREA 39: ROUTE PLANNING

Project 39-1 FY '81

### A Modular Approach to On-Board, Automatic Data Collection Systems

*Research Agency:* The MITRE Corporation  
*Principal Invest.:* Lawrence E. Deibel  
*Effective Date:* November 1, 1982  
*Completion Date:* April 30, 1984  
*Funds:* \$148,787

Current economic conditions require that a transit system improve productivity while making the best use of limited resources. Increasing emphasis is being placed on improving route productivity through such means as better schedules, on-time performance, and service allocation. These requirements place an increasing importance on good ridership and schedule adherence data so that responsible decisions on routing and scheduling can be made. In addition, fare-box revenue is becoming increasingly important to the stability of transit systems. Accurate fare payment information by fare category is needed to calculate effects of alternative fare adjustment proposals, including an analysis of the equity of fare structures. The need for ridership, schedule adherence, and fare information is expected to continue for the foreseeable future.

Currently the most predominant form of gathering ridership data in the transit industry is collecting data manually by ride checks or load (point) checks. Information gathered in this manner is expensive to collect and process, limited in scope, and usually infrequent because of the number of "checkers" required. For example, some systems have reported that a point check may provide accurate load data at one location, but may understate true route ridership by as much as 50 percent. Fare/revenue data are generally available only on a systemwide basis. Special efforts that usually rely on driver participation or cumbersome fare-box handling are required to collect route-level fare-payment information.

In recent years, a few transit systems have turned to automated methods to collect ridership, schedule adherence, and fare data. The levels of sophistication of these systems have varied from real-time data collection and analysis systems to more basic systems that provide information in summary form on an historical basis. Although, in general, transit properties that have used these automated systems have been satisfied, widespread use has not occurred.

There are several reasons why the majority of transit systems have not implemented automated technology: (1) a general lack of understanding of the options available in terms of hardware to provide the information; (2) an uncertainty as to how much of what type of hardware and software is needed; (3) the lack of commitment by transit management to implement the technology; (4) the difficulty in quantifying benefits, together with costs, and in determining the net benefit to the transit system; (5) the general unavailability of funding for much of this equipment at the federal level; and (6) the lack of standardization of functional requirements of the technologies, which, in turn,

dampens the availability of hardware and discourages manufacturer participation.

The general objective of this research is to develop requirements and implementation guidelines for the use of automated on-board passenger/fare information collection systems. The system hardware should be constructed on a modular basis. Depending on the complexity of information desired, the modules should include, but not be limited to: (1) basic passenger counters (e.g., treadle, infrared), (2) location detection devices (e.g., odometer, signposts), (3) fare category counter (e.g., electronic fare-box), and (4) data storage/retrieval equipment (e.g., radio, cassette, solid state). Functional specifications for each of these systems are to be developed so that one module or component is compatible with another regardless of manufacturer. Requirements for modules or components will depend on the decisions a transit property must make, which, in turn, determines the level of detail the data collection system must provide. The levels of detail range from systemwide information to detailed stop-by-stop information. The system should be designed so that a transit property can choose, in modular fashion, the level and type of hardware needed for the data desired. Research to satisfy the general objective will require the following tasks:

*Task 1.* Review existing literature and acquire other information as needed to determine the state of the art of automated data collection systems and information needs requiring passenger counts, schedule adherence, and fare data.

*Task 2.* Determine modular hardware requirements to provide the information desired for various levels of decision-making. Standardize the functional requirements and develop uniform specifications for the hardware by module type. Upon completion of this task, a technical paper containing the specifications will be submitted to NCTRP for review.

*Task 3.* Develop methods to permit transit properties to select the modules and supporting hardware in sufficient quantity, on the basis of a sampling plan, to meet their data needs.

*Task 4.* Develop a format for quantifying all benefits and all costs so that a transit property can determine the overall net benefit compared with alternative means of collecting the data.

*Task 5.* Investigate other considerations that affect implementation, such as labor restrictions, organizational commitment, and maintenance support capability.

*Task 6.* Define data processing requirements (hardware/software) and develop flow charts that describe how various outputs can be produced using the data collected together with such external information as schedule data or mileage data.

*Task 7.* Prepare a manual that describes the methods a transit property would follow to design, select, and implement an automated ridership and fare data collection system. Recommend two (2) transit properties of different sizes to test the application of the manual.

*Task 8.* Demonstrate the validity of the procedures in the manual by applying the techniques to the two (2) transit properties and revise the manual accordingly.

*Task 9.* Prepare a technical specification for procurement that describes the electronic/mechanical requirements of the module interfaces.

*Task 10.* Prepare a final report that includes the revised manual as a stand-alone appendix.

## AREA 40: IMPACT ANALYSIS

Project 40-1 FY '81

### Simplified Guidelines for Evaluating Transit Options in Small Urban Areas

*Research Agency:* Barton-Aschman Associates, Inc.  
*Principal Invest.:* Dr. David R. Miller  
*Effective Date:* October 25, 1982  
*Completion Date:* January 24, 1984  
*Funds:* \$149,960

Small transit systems, as well as larger systems, are caught in a continuing struggle of determining the impacts of transit system investment decisions on users as well as on the community at large. The actual impacts of a transit system are difficult to determine. In addition to the obvious potential impacts, such as changes in vehicle-miles of travel, fuel consumption, pollution, etc., there is also a group of not-so-obvious impacts that relate to the costs and benefits of a transit investment (e.g., vehicle accidents, peak-hour congestion, traffic volume changes, commercial parking space requirements, and changes in future capital costs for street construction). Nonquantifiable impacts must also be considered, such as changes in mobility for the economically disadvantaged and for those who cannot drive (i.e., handicapped, elderly, and young people).

To ensure that city managers and councils have information on which to make intelligent and consistent appraisals pertaining to such investments, many types of factors must be fully considered. Typical factors are (1) socioeconomic (e.g., percentage of elderly population, minority population, chronic unemployment problems, diversity of existing industries, existence of large institutions), (2) political (e.g., attitude of the "affected parties," social-economic advocate groups), (3) current local concerns (e.g., ecology, air quality, traffic congestion), (4) business decisions, and (5) geographic (e.g., climate, topography, proximity to major urban areas).

Transit planning methods for cost-benefit analysis and for alternatives analysis have been well documented in studies sponsored by AASHTO, FHWA, UMTA, and the Office of the Secretary, U.S. DOT. Typically, however, these studies have been too complex and, in many cases, too data intensive for understandable public presentation and use in small cities. Therefore, research is needed to prepare a technically based, yet *simple*, analytical tool for use in the public decision process relating to the potential impacts of transit alternatives.

The objective of this research is to develop procedural guidelines for use by transit and municipal agencies in

guiding their analysis of proposed transit and paratransit alternatives and in presenting their proposals to the decision-making bodies. Use of these guidelines will result in the public's better understanding of proposed investments for a new transit system or improving an existing system. Also, increased use of sound cost-benefit techniques to safeguard against inadequate analyses should result from the availability and use of these guidelines. The guidelines will be designed for application by nontechnical persons and will be directed to the types of decisions faced in urban areas up to 200,000 population. Such considerations as total costs, avoided costs, transportation alternatives, ridership, urban development factors, conservation of energy and other resources, and typical transit evaluation criteria will be included.

Priceable and nonpriceable factors will be identified that need to be included in the guidelines to address the specific concerns of small urban areas (i.e., the factors that are important to the community, city council, etc.). These factors will cover the anticipated impacts on the transit system itself, on transportation in general, and on the community at large (nonuser impacts). Relevant resource materials will be assembled that have applicability to the evaluation of alternatives for public transit. Existing literature and related studies will be reviewed, and a synthesis will be prepared of information relevant to decision-making for transit service options in small urban areas. Information requirements, availability, and sources used in existing analysis techniques will be assessed in relation to the actual needs of small areas.

A set of procedural guidelines will be developed using the best available techniques to describe how to handle both priceable and nonpriceable factors. Equity and distribution questions of who pays and who benefits will be considered. In addition, an educational and portable package will be developed for use in demonstrating the analysis procedures and the factors considered in evaluating transit improvements and alternatives. The package will be suitable for presentations to city councils and transportation planning boards and will be adaptable to local situations.

## AREA 43: TRACK AND ANCILLARY SYSTEMS

Project 43-1 FY '81

### Detection of Low-Level Fault Currents on Rail Transit Systems

*Research Agency:* Chas. T. Main, Inc.  
*Principal Invest.:* Navan S. Sagar  
*Effective Date:* November 15, 1982  
*Completion Date:* February 14, 1984  
*Funds:* \$99,953

Devices presently in use by the rail transit industry can adequately detect and respond to overload fault currents. Detection of less than overload fault currents is particularly difficult because the fault current characteristics tend to resemble characteristics normally associated with train or power switching operations. Rapid and reliable detection

of low-current electrical faults on direct-current rail transit systems would provide a significant improvement to safety and operation of these systems.

The objective of this research is to identify and evaluate detection methods and equipment to enhance transit system safety through reliable detection of electrical faults that are not detected by circuit breaker overload protection. Cooperation by transit systems and associated industries is essential to the success of the project, inasmuch as this research seeks a solution that can easily be adapted to various transit systems.

To accomplish this objective, the following tasks will be conducted:

*Task 1.* Perform an in-depth survey of rail transit systems worldwide, under the auspices of an international institution, such as the International Union of Public Transport, to determine how the problem being researched is handled on each system. Concurrently, survey the electrical industry organizations and suppliers worldwide for methods and equipment that are potential solutions to the detection problem. Review the work of other industries that may also be relevant to the problem and its solution.

*Task 2.* Using information obtained in Task 1, identify the electrical system characteristics that will define the parameters of the required detection systems for various types of vehicle propulsion systems and network configurations.

*Task 3.* Using the parameters developed in Task 2, determine the extent to which available methods and equipment meet the research objectives.

*Task 4.* Prepare a final report describing the research and its results, including a detailed evaluation of the performance and economics of available methods and equipment.

Research is under way on Task 1 of the study involving a survey of rail transit systems to determine how low-level fault currents are being detected.

## AREA 47: GENERAL MATERIALS

Project 47-1 FY '80

### Improved Service Life of Urban Transit Coach Brakes

*Research Agency:* Battelle Memorial Institute  
*Principal Invest.:* Dr. Allen T. Hopper  
*Effective Date:* December 1, 1981  
*Completion Date:* November 30, 1983  
*Funds:* \$300,000

The operation and maintenance history of advanced design urban transit coaches shows a dramatic decline in brake life compared with early "new look" coaches. Major factors associated with this decline in brake life appear to be, but are not limited to: increased gross vehicle weight, increased operating speed, body configuration, and changed regulations.

The resultant increased brake temperatures are believed to be the cause of reduced brake life that has increased operational costs to unacceptable levels. Therefore, the need exists to identify and develop methods to increase brake life to previous levels.

The overall project objective is to develop methodologies for improving existing and future urban transit coach brake life. This will include quantification of in-service brake operating temperatures plus identification of methods of reducing brake operating temperatures and/or alternate friction materials.

The project objective will be accomplished in two phases. Phase I will include the following tasks:

*Task 1.* Confirmation of the premise that temperature is the cause of reduced brake life by the collection and evaluation of brake operating temperatures. This is to be accomplished in cooperation with a major metropolitan transit operator that has experienced the problem. As a minimum, temperature levels will be established for advanced design and early "new look" transit coaches.

*Task 2.* Development of practical methods for reduction of operating temperatures and/or identification of friction materials for compatibility with the service temperatures determined in Task 1. The following factors must be considered: (a) adaptability to coaches in service, (b) initial and operating costs, (c) regulations, (d) serviceability, (e) reliability, (f) public acceptability, and (g) feasibility.

*Task 3.* Cost-benefit prioritization of methods for increasing brake life based on Tasks 1 and 2.

*Task 4.* Preparation of an interim report with recommendations for implementation of Phase II demonstration.

The Phase II effort will include:

*Task 5.* Demonstration of one or more suggested corrective methods based on selection by the panel from those recommended in Phase I. This will be accomplished in cooperation with a major metropolitan transit operator.

*Task 6.* Preparation and submittal of the final report.

Research is essentially completed on Phase I of the study. Accomplishment of Task 1 involved (1) detailed design and construction of brake drum and shoe instrumentation; (2) installation and trial testing of instrumentation on a bus in Columbus, Ohio; (3) obtaining and instrumenting brake drums and shoes for Los Angeles buses; (4) installation of instrumented brake drums and shoes on 3 buses in Los Angeles; and (5) collection of in-service brake temperature data from instrumented buses in Los Angeles. Brake temperatures of up to 600 F were recorded during the data collection activities. Accomplishment of Task 2 involved evaluation of temperature-wear properties of brake materials, development of a model for evaluating temperature reducing methods, and selection of retrofitting schemes for increasing service life of brakes. An interim report covering Phase I is being prepared.

## AREA 54: ENERGY EFFICIENCY

Project 54-1 FY '80

### Improve Transit Bus Energy Efficiency and Productivity

*Research Agency:* Booz, Allen & Hamilton, Inc.  
*Principal Invest.:* Archie M. Riviera  
*Effective Date:* October 1, 1981  
*Completion Date:* June 30, 1982  
*Funds:* \$39,976

Because of rapidly rising fuel prices and uncertain fuel availability, there is a critical need in the transit industry to improve energy efficiency. However, as a result of governmental regulation and other factors, the recent trend in bus technology has actually been toward poorer efficiency. For example, the Advanced Design Buses introduced in recent years require more energy than the buses replaced and, compounding the problem, also have fewer seats. Energy efficiency losses are due to many causes including requirements to satisfy environmental considerations, safety, styling, accessibility, and the like.

The objective of this research was to develop guidelines for transit property managers to follow in specifying a new bus. The researchers cataloged the basic types of equipment and options available in 35-ft, 40-ft, and articulated transit buses. Equipment and options include power train features; special equipment; standard component options; basic design and safety features; and environmental controls. Estimates of the relative energy consumption levels of the various items of equipment and options were developed. For each bus type and size, a baseline equipment configuration was specified and the energy-consumption characteristics of each option were related to the baseline. An approach was developed for estimating energy-efficiency characteristics of buses over the full range of operating environments (e.g., terrain, altitude, climate, maximum operating speed, number of stops per mile).

Research has been completed, and the final report has been published as:

NCTRP Report 1, "Transit Bus Energy Efficiency and Productivity—Bus Equipment Selection Handbook." This report includes a concise set of guidelines for use by managers of individual transit properties in selecting and specifying buses for purchase. The guidelines focus on the energy efficiency and productivity of different bus types, equipment, and options and are applicable to properties of all sizes and geographic locations. Sample data for vehicle characteristics are provided for illustrative purposes, but current vehicle data should be obtained from the manufacturers when using the guidelines.

Project 54-2 FY '80

### Energy Management of Electric Rail Transit Systems

*Research Agency:* Carnegie-Mellon University  
*Principal Invest.:* Dr. Richard A. Uher  
*Effective Date:* October 1, 1981  
*Completion Date:* March 31, 1983  
*Funds:* \$135,115

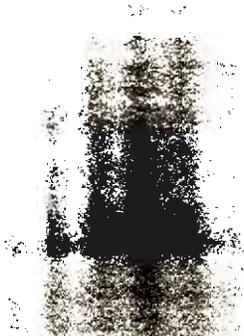
Rapidly increasing electric energy costs have resulted in a dramatic increase in operating expenses of transit authorities operating electric rail systems. This problem is further augmented by additional increases in rates being sought by electric utilities. The peak demand component of these rates is directly associated with the electric energy generation, transmission, and distribution facilities cost. As major electric energy consumers, transit authorities are subject to allocated costs associated with these facilities. If transit authorities can improve the management of peak demand on their systems, energy costs can be significantly reduced. Several transit authorities have developed strategies for: reducing peak energy consumption (such as load management), improving vehicle energy efficiency, and more energy efficient operating practices.

The objective of this research is to provide guidelines for transit authorities to lower peak electric demand and, thereby, lower costs. It is anticipated that the proposed study will include but not be limited to:

1. Identification of the contributing factors that cause peak demand and the timing and significance of each.
2. Identification of monitoring strategies and conservation opportunities in order to be able to control peak demand.
3. Identification and evaluation of various load management techniques and their cost/benefits and effectiveness on reducing peak demand.
4. Development of strategies so that the benefits of peak demand management are reflected in rates.

It is intended that the research will result in the development of methodologies for: (1) forecasting the peak electric energy demand, (2) monitoring the actual demand, and (3) controlling the demand. It is also intended that a preliminary plan will be prepared for validating and demonstrating the developed methodologies.

Research is in progress. Data were initially collected from four transit agencies and analyzed to determine probable peak power demand causes. Monitoring strategies have been identified for controlling peak demand and the costs of the various strategies determined. As these activities were nearing completion, data became available from a fifth transit agency that was considered useful in verifying the strategies for reducing peak power demand. Funds were available to analyze these additional data, so the contract was amended to provide an additional 3 months necessary to complete the additional analysis. Proposed load management strategies have been evaluated using simulation models. The preliminary draft final report is being prepared.



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