TCRP SYNTHESIS 54

TRANSIT COOPERATIVE RESEARCH PROGRAM

Sponsored by the Federal Transit Administration

Maintenance Productivity Practices

A Synthesis of Transit Practice

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

TCRP

TRANSIT
COOPERATIVE
RESEARCH
PROGRAM

SYNTHESIS 54

Sponsored by
the Federal
Transit Administration

Maintenance Productivity Practices

A Synthesis of Transit Practice

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

TCRP OVERSIGHT AND PROJECT SELECTION COMMITTEE
(Membership as of June 2004)

CHAIR
SHARON GREENE
Sharon Greene & Associates

MEMBERS
KAREN ANTION
Karen Antion Consulting
LINDA J. BOHLINGER
HNTB Corp.
ROBERT I. BROWNSTEIN
Parsons Brinckerhoff Quade & Douglas, Inc.
PETER A. CANNITO
Metropolitan Transit Authority—Metro-North Railroad
GREGORY COOK
Ann Arbor Transportation Authority
JENNIFER L. DORN
Federal Transit Administration
NATHANIEL P. FORD, SR.
Metropolitan Atlanta RTA
RONALD L. FREELAND
Parsons Transportation Group
FRED M. GILLIAM
Capital Metropolitan Transportation Authority
KIM R. GREEN
GFI GENFARE
JILL A. HOUGH
North Dakota State University
ROBERT H. IRWIN
British Columbia Transit
JEANNE W. KRIEG
Eastern Contra Costa Transit Authority
CELIA G. KUPERSMITH
Golden Gate Bridge, Hwy. & Transport. Dist.
PAUL J. LARROUSSE
National Transit Institute
DAVID A. LEE
Connecticut Transit
CLARENCE W. MARSELLA
Denver Regional Transportation District
FAYE L.M. MOORE
Southeastern Penn. Transportation Authority
MICHAEL H. MULHERN
Massachusetts Bay Transportation Authority
STEPHANIE L. PINSON
Gilbert Tweed Associates, Inc.
ROBERT H. PRINCE, JR.
DMJM+Harris
JEFFREY M. ROSENBERG
Amalgamated Transit Union
BEVERLY A. SCOTT
Sacramento Regional Transit District
PAUL P. SKOUTELAS
Port Authority of Allegheny County
KATHRYN D. WATERS
Dallas Area Rapid Transit

EX OFFICIO MEMBERS
WILLIAM W. MILLAR
APTA
MARY E. PETERS
FHWA
JOHN C. HORSLEY
AASHTO
ROBERT E. SKINNER, JR.
Transportation Research Board

TDC EXECUTIVE DIRECTOR
LOUIS F. SANDERS
APTA

SECRETARY
ROBERT J. REILLY
TRB

TRANSPORTATION RESEARCH BOARD EXECUTIVE COMMITTEE 2004
(Membership as of July 2004)

OFFICERS

Chair: MICHAEL S. TOWNES, *President and CEO, Hampton Roads Transit, Hampton, VA*
Vice Chairman: JOSEPH H. BOARDMAN, *Commissioner, New York State DOT*
Executive Director: ROBERT E. SKINNER, JR., *Transportation Research Board*

MEMBERS

MICHAEL W. BEHRENS, *Executive Director, Texas DOT*
SARAH C. CAMPBELL, *President, TransManagement, Inc., Washington, DC*
E. DEAN CARLSON, *Director, Carlson Associates, Topeka, KS*
JOHN L. CRAIG, *Director, Nebraska Department of Roads*
DOUGLAS G. DUNCAN, *President and CEO, FedEx Freight, Memphis, TN*
GENEVIEVE GIULIANO, *Director, Metrans Transportation Center and Professor, School of Policy, Planning, and Development, USC, Los Angeles*
BERNARD S. GROSECLOSE, JR., *President and CEO, South Carolina State Ports Authority*
SUSAN HANSON, *Landry University Professor of Geography, Graduate School of Geography, Clark University*
JAMES R. HERTWIG, *President, CSX Intermodal, Jacksonville, FL*
GLORIA J. JEFF, *Director, Michigan DOT*
ADIB K. KANAFANI, *Cahill Professor of Civil Engineering, University of California, Berkeley*
RONALD F. KIRBY, *Director of Transportation Planning, Metropolitan Washington Council of Governments*
HERBERT S. LEVINSON, *Principal, Herbert S. Levinson Transportation Consultant, New Haven, CT*
SUE McNEIL, *Director, Urban Transportation Center and Professor, College of Urban Planning and Public Affairs and Department of Civil and Material Engineering, University of Illinois, Chicago*
MICHAEL D. MEYER, *Professor, School of Civil and Environmental Engineering, Georgia Institute of Technology*
CAROL A. MURRAY, *Commissioner, New Hampshire DOT*
JOHN E. NJORD, *Executive Director, Utah DOT*
DAVID PLAVIN, *President, Airports Council International, Washington, DC*
JOHN H. REBENSDORF, *Vice President, Network Planning and Operations, Union Pacific Railroad Company, Omaha, NE*
PHILIP A. SHUCET, *Commissioner, Virginia DOT*
C. MICHAEL WALTON, *Ernest H. Cockrell Centennial Chair in Engineering, University of Texas, Austin*
LINDA S. WATSON, *Executive Director, LYNX, Central Florida Regional Transportation Authority, Orlando, FL*

EX OFFICIO MEMBERS

MARION C. BLAKEY, *Federal Aviation Administrator, U.S. DOT*
SAMUEL G. BONASSO, *Acting Administrator, Research and Special Programs Administration, U.S. DOT*
REBECCA M. BREWSTER, *President and COO, American Transportation Research Institute, Smyrna, GA*
GEORGE BUGLIARELLO, *Chancellor, Polytechnic University and Foreign Secretary, National Academy of Engineering*
THOMAS H. COLLINS (Adm., U.S. Coast Guard), *Commandant, U.S. Coast Guard*
JENNIFER L. DORN, *Federal Transit Administrator, U.S. DOT*
EDWARD R. HAMBERGER, *President and CEO, Association of American Railroads*
JOHN C. HORSLEY, *Executive Director, American Association of State Highway and Transportation Officials*
RICK KOWALEWSKI, *Deputy Director, Bureau of Transportation Statistics, U.S. DOT*
WILLIAM W. MILLAR, *President, American Public Transportation Association*
BETTY MONRO, *Acting Administrator, Federal Railroad Administration, U.S. DOT*
MARY E. PETERS, *Federal Highway Administrator, U.S. DOT*
SUZANNE RUDZINSKI, *Director, Transportation and Regional Programs, U.S. Environmental Protection Agency*
JEFFREY W. RUNGE, *National Highway Traffic Safety Administrator, U.S. DOT*
ANNETTE M. SANDBERG, *Federal Motor Carrier Safety Administrator, U.S. DOT*
WILLIAM G. SCHUBERT, *Maritime Administrator, U.S. DOT*
JEFFREY N. SHANE, *Under Secretary for Policy, U.S. DOT*
CARL A. STROCK (Maj. Gen., U.S. Army), *Chief of Engineers and Commanding General, U.S. Army Corps of Engineers*
ROBERT A. VENEZIA, *Program Manager of Public Health Applications, National Aeronautics and Space Administration*

TRANSIT COOPERATIVE RESEARCH PROGRAM

Transportation Research Board Executive Committee Subcommittee for TCRP

MICHAEL S. TOWNES, *Hampton Roads Transit, Hampton, VA* (Chair)
JOSEPH H. BOARDMAN, *New York State DOT*
JENNIFER L. DORN, *Federal Transit Administration, U.S. DOT*
GENEVIEVE GIULIANO, *University of Southern California, Los Angeles*
WILLIAM W. MILLAR, *American Public Transportation Association*
ROBERT E. SKINNER, JR., *Transportation Research Board*
C. MICHAEL WALTON, *University of Texas, Austin*
LINDA S. WATSON, *LYNX, Central Florida Regional Transportation Authority, Orlando, FL*

TRANSIT COOPERATIVE HIGHWAY RESEARCH PROGRAM

TCRP SYNTHESIS 54

Maintenance Productivity Practices

A Synthesis of Transit Practice

CONSULTANT

FRANK W. VENEZIA
Lea+Elliott, Inc.
Naperville, Illinois

TOPIC PANEL

UTPAL DUTTA, *University of Detroit Mercy*
BRUCE HOBBS, *Washington Metropolitan Area Transit Authority*
FRANK LISLE, *Transportation Research Board*
DARRYL PARHAM, *Dallas Area Rapid Transit*
ALLEN PIERCE, *Orange County Transportation Authority*
J.F. ROSAPEPE, *Pierce Transit*
RONALD J. SHIPLEY, *Pierce Transit*
LURAE STUART, *American Public Transportation Authority*
JOHN P. WALSH, *Metropolitan Transportation Authority New York City Transit*
MICHAEL CONNOR, *Federal Highway Administration* (Liaison)

SUBJECT AREAS
Public Transit

Research Sponsored by the Federal Transit Administration in Cooperation with the Transit Development Corporation

TRANSPORTATION RESEARCH BOARD

WASHINGTON, D.C.
2004
www.TRB.org

TRANSIT COOPERATIVE RESEARCH PROGRAM

The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands. Research is necessary to solve operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

The need for TCRP was originally identified in *TRB Special Report 213—Research for Public Transit: New Directions*, published in 1987 and based on a study sponsored by the Federal Transit Administration (FTA). A report by the American Public Transportation Association (APTA), *Transportation 2000*, also recognized the need for local, problem-solving research. TCRP, modeled after the longstanding and successful National Cooperative Highway Research Program, undertakes research and other technical activities in response to the needs of transit service providers. The scope of TCRP includes a variety of transit research fields including planning service configuration, equipment, facilities, operations, human resources, maintenance, policy, and administrative practices.

TCRP was established under FTA sponsorship in July 1992. Proposed by the U.S. Department of Transportation, TCRP was authorized as part of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). On May 13, 1992, a memorandum agreement outlining TCRP operating procedures was executed by the three cooperating organizations: FTA, the National Academy of Sciences, acting through the Transportation Research Board (TRB), and the Transit Development Corporation, Inc. (TDC), a nonprofit educational and research organization established by APTA. TDC is responsible for forming the independent governing board, designated as the TCRP Oversight and Project Selection (TOPS) Committee.

Research problem statements for TCRP are solicited periodically but may be submitted to TRB by anyone at anytime. It is the responsibility of the TOPS Committee to formulate the research program by identifying the highest priority projects. As part of the evaluation, the TOPS Committee defines funding levels and expected products.

Once selected, each project is assigned to an expert panel, appointed by TRB. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, TCRP project panels serve voluntarily without compensation.

Because research cannot have the desired impact if products fail to reach the intended audience, special emphasis is placed on disseminating TCRP results to the intended end-users of the research: transit agencies, service providers, and suppliers. TRB provides a series of research reports, syntheses of transit practice, and other supporting material developed by TCRP research. APTA will arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by urban and rural transit industry practitioners.

The TCRP provides a forum where transit agencies can cooperatively address common operational problems. TCRP results support and complement other ongoing transit research and training programs.

TCRP SYNTHESIS 54

Project J-7, Topic SE-02
ISSN 1073-4880
ISBN 0-309-07013-9
Library of Congress Control No. 2004110115

© 2004 Transportation Research Board

Price $18.00

NOTICE

The project that is the subject of this report was a part of the Transit Cooperative Research Program conducted by the Transportation Research Board with the approval of the Governing Board of the National Research Council. Such approval reflects the Governing Board's judgment that the project concerned is appropriate with respect to both the purposes and resources of the National Research Council.

The members of the technical advisory panel selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and while they have been accepted as appropriate by the technical panel, they are not necessarily those of the Transportation Research Board, the Transit Development Corporation, the National Research Council, or the Federal Transit Administration of the U.S. Department of Transportation.

Each report is reviewed and accepted for publication by the technical panel according to procedures established and monitored by the Transportation Research Board Executive Committee and the Governing Board of the National Research Council.

Special Notice

The Transportation Research Board of the National Academies, the Transit Development Corporation, the National Research Council, and the Federal Transit Administration (sponsor of the Transit Cooperative Research Program) do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the clarity and completeness of the project report.

Published reports of the

TRANSIT COOPERATIVE RESEARCH PROGRAM

are available from:

Transportation Research Board
Business Office
500 Fifth Street, NW
Washington, D.C. 20001

and can be ordered through the Internet at:

http://www.national-academies.org/trb/bookstore

Printed in the United States of America

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

The **National Academy of Sciences** is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. On the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Bruce M. Alberts is president of the National Academy of Sciences.

The **National Academy of Engineering** was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. William A. Wulf is president of the National Academy of Engineering.

The **Institute of Medicine** was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, on its own initiative, to identify issues of medical care, research, and education. Dr. Harvey V. Fineberg is president of the Institute of Medicine.

The **National Research Council** was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Bruce M. Alberts and Dr. William A. Wulf are chair and vice chair, respectively, of the National Research Council.

The **Transportation Research Board** is a division of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering. The Board's mission is to promote innovation and progress in transportation through research. In an objective and interdisciplinary setting, the Board facilitates the sharing of information on transportation practice and policy by researchers and practitioners; stimulates research and offers research management services that promote technical excellence; provides expert advice on transportation policy and programs; and disseminates research results broadly and encourages their implementation. The Board's varied activities annually engage more than 5,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation. **www.TRB.org**

www.national-academies.org

FOREWORD

By Staff
Transportation
Research Board

Transit administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to the transit industry. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire transit community, the Transit Cooperative Research Program Oversight and Project Selection (TOPS) Committee authorized the Transportation Research Board to undertake a continuing study. This study, TCRP Project J-7, "Synthesis of Information Related to Transit Problems," searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute a TCRP report series, *Synthesis of Transit Practice*.

The synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems.

PREFACE

This synthesis will be of interest to transit agency staff responsible for vehicle maintenance and planning at their agencies. Staff can use this report to learn from the experiences of other agencies, as well as to compare their experiences with those of other agencies. It documents and summarizes transit agency experiences, using various maintenance productivity improvements and programming. The report summarizes the experiences of agencies that vary in size, union affiliation, and operating conditions. It provides descriptions of successful programs and creative modifications to existing programs.

This report from the Transportation Research Board integrates information from several sources. It is based on data collected from a review of the relevant literature and a survey of transit agencies. Information was provided by 26 transit agencies. Survey responses were supplemented by follow-up interviews with transit agency staff.

A panel of experts in the subject area guided the work of organizing and evaluating the collected data and reviewed the final synthesis report. A consultant was engaged to collect and synthesize the information and to write the report. Both the consultant and the members of the oversight panel are acknowledged on the title page. This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

CONTENTS

1 SUMMARY

3 CHAPTER ONE INTRODUCTION
Objective, 3
Methodology, 3
Synthesis Organization, 4

5 CHAPTER TWO DISCUSSION OF BUS MAINTENANCE PRODUCTIVITY
Industry Standards, 5
Transit Agency Methodologies, 6
New Technology, 13
Union and Management Issues, 13
Training Concerns, 15
Quality Issues, 16
Update on Related Syntheses, 17

18 CHAPTER THREE TRANSIT AGENCY PROGRAMS AND ISSUES—CASE STUDIES
Milwaukee County Transit System, 18
Metropolitan Transportation Authority New York City Transit, 19
Metropolitan Transit Authority of Harris County, Texas, 20
Orange County Transportation Authority, 21
King County Metro Transit—Seattle, 22
Massachusetts Bay Transportation Authority, 23
Coast Mountain Bus Company, 24

27 CHAPTER FOUR CONCLUSIONS

29 REFERENCES

30 BIBLIOGRAPHY

31 ABBREVIATIONS AND ACRONYMS

32 APPENDIX A SURVEY QUESTIONNAIRE

43 APPENDIX B CONDENSED SUMMARY OF SURVEY RESPONSES

47 APPENDIX C MTA NYCT—ADDITIONAL STANDARD REPAIR TIMES INFORMATION

81 APPENDIX D HOUSTON METRO—ADDITIONAL INFORMATION ON PAINTING

91 APPENDIX E ORANGE COUNTY TRANSPORTATION AUTHORITY—ADDITIONAL INFORMATION ON UNION AGREEMENT

TCRP COMMITTEE FOR PROJECT J-7

CHAIR
FRANK T. MARTIN
PBS&J, Tallahassee, FL

MEMBERS
DEBRA W. ALEXANDER
Capital Area Transportation Authority, Lansing, MI
DWIGHT FERRELL
The Ferrell Group, Richardson, TX
MARK W. FUHRMANN
Metro Transit, Minneapolis, MN
ROBERT H. IRWIN
British Columbia Transit, Victoria, BC
PAUL J. LARROUSSE
National Transit Institute, New Brunswick, NJ
WADE LAWSON
South Jersey Transportation Authority, Atlantic City, NJ
DAVID A. LEE
Connecticut Transit, Hartford, CT
DAVID PHELPS
Consultant, Moneta, VA
HAYWARD M. SEYMORE, III
Laidlaw Transit Services, Inc., University Place, WA
PAM WARD
Ottumwa Transit Authority, IA
JOEL R. WASHINGTON
Washington Metropolitan Area Transit Authority, DC

FTA LIAISON
KAREN FACEN
Federal Transit Administration

TRB LIAISON
PETER L. SHAW
Transportation Research Board

COOPERATIVE RESEARCH PROGRAMS STAFF
ROBERT J. REILLY, *Director, Cooperative Research Programs*
CHRISTOPHER W. JENKS, *Manager, TCRP*
EILEEN DELANEY, *Editor*

TCRP SYNTHESIS STAFF
STEPHEN R. GODWIN, *Director for Studies and Information Services*
JON WILLIAMS, *Manager, Synthesis Studies*
DONNA L. VLASAK, *Senior Program Officer*
DON TIPPMAN, *Editor*
CHERYL Y. KEITH, *Senior Secretary*

ACKNOWLEDGMENTS

Frank W. Venezia, Lea+Elliot, Inc., Naperville, Illinois, was responsible for collection of the data and preparation of the report.

Valuable assistance in the preparation of this synthesis was provided by the Topic Panel, consisting of Michael Connor, Office of Engineering/Program Management, Federal Transit Administration; Utpal Dutta, Professor and Chair, Civil and Environmental Engineering, University of Detroit Mercy; Bruce Hobbs, Assistant General Superintendent of Bus Maintenance, Department of Operations, Washington Metropolitan Area Transit Authority; Frank Lisle, Senior Program Officer, Transportation Research Board; Darryl Parham, Senior Manager, Dallas Area Rapid Transit; Allen Pierce, Manager, Maintenance, Orange County Transportation Authority; J.F. Rosapepe, Acting Vice President, Maintenance, Pierce Transit; Ronald J. Shipley, Vice President, Maintenance, Pierce Transit; Lurae Stuart, American Public Transportation Association; and John P. Walsh, Chief Maintenance Officer, Metropolitan Transportation Authority New York City Transit.

This study was managed by Donna L. Vlasak, Senior Program Officer, who worked with the consultant, the Topic Panel, and the J-7 project committee in the development and review of the report. Assistance in project scope development was provided by Jon Williams, Manager, Synthesis Studies. Don Tippman was responsible for editing and production. Cheryl Keith assisted in meeting logistics and distribution of the questionnaire and draft reports.

Christopher W. Jenks, Manager, Transit Cooperative Research Program, assisted TCRP staff in project review.

Information on current practice was provided by many transit agencies. Their cooperation and assistance was most helpful.

MAINTENANCE PRODUCTIVITY PRACTICES

SUMMARY

Maintenance productivity concepts have been around since public transit agencies were founded. In the 1980s, transit agencies were compelled to set time standards for repetitive maintenance tasks, preventive maintenance programs, and repair functions. Repair times and written procedures for maintenance tasks were established and provided as productivity improvement tools. Some were successful; others were not. The advent of computerized maintenance record keeping in the 1990s facilitated data collection, analysis, and information dissemination, and supported faster problem solving. However, the nature of public transit agency operations requires that transit agencies continually strive to do more with less. Currently, tight operating budgets are forcing transit agencies to look closely at productivity improvements without compromising safety and quality.

Transit agency operating budgets have been the subject of in-depth review to be more efficient concerning the costs of performing maintenance. In response, public and political interests are increasing the pressure on transit agencies to be more efficient, reduce costs, and improve service before increasing fares.

For public transit agencies to improve productivity, management must communicate a strong commitment down through the ranks of the agency, and the employee union must be included as a partner. Agencies that have already partnered with the employee unions to institute productivity programs have shown success in demonstrating that a productivity improvement program can provide a more efficient and safer use of personnel at a lower cost.

The results of a survey and follow-up telephone interviews indicate that all transit agencies are interested in increasing productivity, and a large body of information and documentation is widely shared throughout the industry. Documented work procedures and processes are the first necessary steps. Some agencies have sufficient staff to generate their own documentation, whereas others modify documents obtained from the manufacturers and/or other transit agencies to conform to their own operating conditions. A few transit systems have provided internal documentation on standards for use by other agencies and have posted them on the TRB's Transit Maintenance Webboard (http://webboard.trb.org/~A1E16).

Many transit agencies use standards as a guide to what they expect their employees to meet when accomplishing a specific maintenance task, and some agencies use the standards as a goal. The term "standard repair time" is now being used to describe the proper procedures and time required to accomplish those procedures. However, most agencies will consider using a standard that includes a timely procedure, including safety and quality factors.

The survey found that the most common performance indicators for ensuring quality, reducing costs, and improving productivity include road calls, repeat failures, making pullouts, component rebuild costs, and component life. Monitoring of those indicators is important. Also, incentive programs can be successfully integrated into productivity improvement programs and simultaneously increase employee morale. The survey also indicated that integrating

parts kits and bills of material, special tools, and equipment produces positive improvements.

All agencies agreed that training is an important factor in productivity improvement. The use of the electronic diagnostic features of the engine, transmission, and other components has been found to reduce overall diagnostics time. Additional training is always desired, especially where there is new equipment and newer diagnostic technology.

This synthesis summarizes the experiences of transit properties that vary in size, union affiliation, and operating conditions in using various maintenance productivity improvements and programs. It also provides descriptions of successful programs and creative modifications to existing programs.

CHAPTER ONE

INTRODUCTION

The economic slowdown has had an impact on many companies and organizations in both the public and private sectors throughout the country. Affected are the levels of necessary operating revenue relied on by public transit agencies. This economic climate is prompting everyone, including public transit agencies, to rethink current practices and business methods, and it is prompting public transit agencies to strive for productivity improvements and efficiency gains to be better, faster, and cheaper. Maintenance department budgets are typically the second largest component of the total operating costs of a transit system, and the maintenance budget is a frequent target for cost reductions. Maintenance budget reductions will force transit agencies to further improve the productivity and efficiency of their maintenance practices or to consider outsourcing work that they would have normally done within the agency.

In the past, transit agencies developed programs to improve the efficiency of general maintenance practices by using a wide variety of methods and procedures. Some methods have been successful, whereas others can only be classified as "dismal failures." Transit agencies must now use their existing funding in the most efficient method possible by improving and emphasizing productivity programs that will reduce costs and/or improve efficiency. The savings will be used to adjust for unavoidable future budget cuts and for funding of continued productivity improvement tools, including training, diagnostic programs, tools and equipment, material review studies, and employee incentive programs.

Employee union concerns must be a prime consideration when emphasizing productivity improvements. Unions do not want to see a reduction in the workforce, and they must be willing to work as part of a team effort to improve productivity. A close working relationship of transit agencies with union representatives can provide the solid common ground necessary for any productivity improvement program. A collective bargaining agreement delineates the rules and regulations that must be followed by both the union maintenance employees and transit agency management. Most of the transit agencies' collective bargaining agreements do not have specific wording on time standards for repair work that provide the basis of some productivity improvement programs. The efficient use of personnel is a key element in a productivity improvement plan, and a transit agency should consider the introduction of repair work time standards into the collective bargaining agreement. Transit agency management must present to union representatives how time standards can contribute to efficiency that may help to avoid service cuts and retain the existing personnel. This is not an easy process; however, it is a valuable and necessary one if the productivity plan is to be successful.

Productivity improvement approaches require standardized processes and procedures to document and ensure that most maintenance employees are achieving the established standards. The initial processes and procedures should be developed by the transit industry and then refined with input from transit agency employees to adapt to local conditions and requirements. Time measurement should not be the only input used to define a standard. Factors that influence the quality of the work product and employee safety should be included; otherwise, time lost as a result of on-the-job injuries will have a detrimental effect both on employee morale and the productivity of the entire work area. In this synthesis, time, quality, and safety are included as primary concerns in developing standards with the objectives of achieving cost reductions in maintenance.

OBJECTIVE

The objective of this synthesis is to research and disseminate information on operational productivity improvement within public transit agencies and from other sources to any agency that would be interested in maintenance efficiency improvements.

METHODOLOGY

A literature search on the World Wide Web has provided some information on the processes used to develop existing published practices that can be used to improve maintenance productivity. Most of the existing maintenance productivity documentation and data use industrial engineering (IE) standards that were developed during and right after World War II to improve the output of factories for the war effort. Those standards have been continually refined since then. The basic idea of reducing costs has been ongoing from the onset of the standards. Transit managers have always been interested in reducing costs. When computerized record keeping began to mature, some transit systems began using this technology to gather data for productivity improvements.

To gather information on what transit agencies have been doing to improve productivity, the survey questionnaire (see Appendix A) was distributed to a large variety of transit agencies in North America. The questionnaire was first posted on the APTA and TRB websites, before being mailed to selected transit agencies, to allow additional time for completing the request and to allow other agencies to express interest. Both of those websites were established for transit agency maintenance staff to post problems and receive responses from their peers.

Of 70 transit agencies contacted, 26 completed and returned the survey. Telephone interviews were held with various respondents to gather additional information and clarifications. A matrix of the respondents is included as Appendix B.

The survey was limited to documentation involving heavy-duty bus fleets and requested the following information:

- A breakdown of the individual transit agency's fleet;
- Documented maintenance practices with standard times to accomplish the task;
- Characteristics of the agency's organization to perform quality assurance for maintenance tasks;
- Details on preventive maintenance (PM) programs, major repairs, and individual component rebuild;
- Productivity measurement procedures;
- Classification of maintenance personnel and union affiliation;
- Methods of determining whether maintenance work should be done in-house or contracted to outside vendors;
- Collective bargaining agreement clauses dealing with the setting of time standards;
- New technology diagnostic tools that have aided productivity improvements;
- Road calls and other performance-indicating documentation methods that have aided maintenance productivity evaluation;
- Maintenance productivity techniques and practices; and
- Agencies' willingness to share their programs or plans for this synthesis.

SYNTHESIS ORGANIZATION

Chapter two of this synthesis covers various areas of bus maintenance productivity and current practices of maintenance productivity improvement used by some of the public transit agencies. The examples used discuss how new technology can support productivity improvement, as well as how to address the critical success factors involving union agreements, training concerns, preservation of quality, and safety. Chapter three features case studies that summarize programs and issues of the selected transit systems. Chapter four concludes with a summary of the findings and recommendations for further study.

The report includes five appendixes. Appendix A reproduces the survey questionnaire sent to the transit agencies, Appendix B features a matrix of the responding agencies and a condensed summary of their responses, Appendix C includes additional documents from the Metropolitan Transportation Authority of New York City Transit (MTA NYCT), Appendix D includes additional documents from Houston Metro, and Appendix E provides additional documents from the Orange County Transportation Authority (OCTA).

CHAPTER TWO

DISCUSSION OF BUS MAINTENANCE PRODUCTIVITY

INDUSTRY STANDARDS

Background

Modern IE standards are based on the following general headings by Morley H. Mathewson, as found in the second edition of the *Industrial Engineering Handbook* (*1*):

1. Methods Engineering—study of operations, analysis, motion, material handling, production planning, safety, and standardization.
2. Work Measurement—processes involving time study and predetermined elemental time standards.
3. Control Determination—control of production, inventory, quality, cost, and budgets.
4. Wage and Job Evaluation—wage incentives, profit sharing, job evaluation, merit rating, and wage and salary administration.
5. Plant Facilities and Design—plant layout, equipment procurement and replacement, product design, and tool and gauge design.

Over the years, the military has adopted Mathewson's general categories and improved on them. The automotive and trucking industries adopted the military's approach, and the advent of the computer led to improved techniques and procedures. The transit industry, closely linked with the trucking industry, has also been interested in improvements in productivity in that area.

A more recent book that details the IE approach to improving productivity is by Donald R. Herzog, *Industrial Engineering Methods and Controls* (*2*). This book provides updated methods and controls that can be used for IE and management studies. It also offers insight into developing programs for the optimum use of resources, providing management with information to make the proper decisions, and improving the efficiency and effectiveness of the organization. It breaks down the program into five major functions:

1. Planning—basis for the operations of the organization and determining how much time and resources are necessary to reach a recognized goal;
2. Organizing—how to get things done efficiently by promoting efficiency, morale, and production of the group;
3. Directing—how to keep the company on its plotted course—motivation is an essential element;
4. Coordinating—how a company can meet goals through balanced and cohesive efforts from all resources available; and
5. Controlling—continuous attention to the previous four areas to ensure the execution of programs to meet the objective.

General Methodology

A general methodology for implementing a productivity improvement program begins with a formal standardized process and procedure to document the task to be completed—the determination of a standard repair time (SRT). A good definition of SRT is one used by a major engine manufacturer, as follows (*3*).

> Standard Repair Times (SRT) are lists of work tasks (procedures) and the time required to perform those tasks. The procedures list the work tasks required to be sure an engine is ready to return to service at the lowest possible cost to the customer. A Standard Repair Time is equitable when the repair described in the procedure can be performed in a period less than or equal to the standard by a journeyman mechanic after he/she has performed that repair on the same engine model, in the same application at least once. Those SRT that a particular mechanic performs more frequently will often require less time than the standard. Conversely, those SRT that a particular mechanic does not frequently perform may require more time than the standard. Several of the procedures may be required to actually depict all the work actually performed to return a particular engine to service because the repair of a particular engine is often unique in the light of the complaint, failure mode, progressive damage, condition of the parts, and customer desires.

That engine manufacturer also went on to discuss the three different types of SRT:

1. Administrative—time required to move the vehicle to and from the work area, obtain the necessary information for proper documentation of the repair, and obtain tools and equipment required for the proper repair;
2. Troubleshooting—time used in determining the problem; and
3. Repair—time used to accomplish the actual repair.

A combination of administrative, troubleshooting, and repair activities would constitute the time it takes to complete the entire repair. Although this time was specifically for engines, the term "engine" can be replaced by a term for any component on the bus.

A time study of the task is then attempted to determine the average time needed to accomplish the task and establish the standard. A properly trained and qualified worker proceeds with the task at a normal pace, experiencing normal fatigue and delays. That worker must be supervised by an experienced supervisory person. The proper tools and equipment must be readily available at a proper work location, and all the parts needed to accomplish the task must be readily available. The average time standard is then established by using multiples of the tasks performed by different workers.

Information on the use of standard maintenance job times for transit bus maintenance was presented in a 1984 publication from the National Cooperative Transit Research Program (NCTRP: a predecessor of the TCRP): *NCTRP Synthesis of Transit Practice 4: Allocation of Time for Transit Bus Maintenance Functions* (*4*). That study, however, has limited appeal because it focuses on work time but does not take into consideration quality measurements. Without including work quality and quantified cost savings, time standards have limited applicability.

To ensure that work quality is achieved, there must be a documented procedure validated to produce accurate and repeatable results. Documented procedures serve as the basis for measuring work quality, work productivity, and cost, because the procedures ensure that the performance measures are compared with work tasks performed in a like manner. Without established procedures, workers are free to undertake tasks in any manner. Measuring performance also requires employee training in the work procedures and a method of overseeing work quality. Additional information will be provided later in this chapter.

The two transit agencies highlighted in *Synthesis of Transit Practice 4* were Metro Transit in Seattle, Washington, and the Chicago Transit Authority (CTA). Metro Transit used a sampling method whereby mechanics were observed doing certain tasks. The observed job times were averaged and included other activities such as hostling vehicles, paperwork, steam cleaning, and road testing. CTA used published IE time standards supported by management and the union (*5*). Most of the other transit-related studies that investigated maintenance productivity improvement programs were done in the 1980s and early 1990s with funding provided by the Urban Mass Transportation Administration, the predecessor of the FTA.

Road-call information is used by most transit agencies to determine the effectiveness of the maintenance program, and it can also be used to monitor the quality of the PM program. The exact definition of a road call varies among agencies, which makes direct comparisons difficult. Most responding transit agencies use road-call mileage information to set goals to measure productivity and the quality of their PM programs, and they strive to improve road-call mileage every year.

Transit agencies promote safety programs to improve employee availability and productivity. Time lost from work reduces the active workforce and has a negative impact on productivity. Extended time off may mean the reassignment of personnel to cover any absence. Some of the larger agencies have a dedicated safety department that reviews injuries and makes recommendations on how to prevent them. Many employee injuries can be avoided with proper training and safety protective equipment. Many transit agencies have programs or incentives for perfect or close-to-perfect attendance. Some use "no lost time due to injuries on the job" as a goal and provide incentives and rewards for meeting that goal. Others have programs and incentives for job safety.

TRANSIT AGENCY METHODOLOGIES

Almost all agencies that responded to the questionnaire have some type of maintenance productivity improvement program. They vary from agency to agency, but the goal is still the same: improvement of maintenance productivity through various processes that result in a reliable and safe product at a low cost. Strong management support for improving productivity and a willingness to work with employees and their unions are required.

Computer software is an important element in any productivity improvement program to keep track of individual maintenance functions, including procedures, tools and parts; vehicle information and mileage; and actual time and costs expended for the work to be completed. Such software programs can provide the transit agencies with the information needed to review and monitor maintenance productivity. They also offer the capability to easily sort information to provide detailed reports. Within computerized record keeping, employee time can be recorded along with the work task, thereby eliminating the need for time cards. These software programs also generate performance indicators that can be used to set goals and identify areas that need improvement. Although the software programs are cost-effective and readily available, many transit agencies have not yet taken advantage of electronic record keeping. Some properties still maintain at least a partial paper system.

Maintenance Processes and Procedures

Transit agencies begin productivity improvement programs with a process-and-procedure document that delineates the step-by-step process (troubleshooting, repair, and component replacement and rebuilding) to complete a given task.

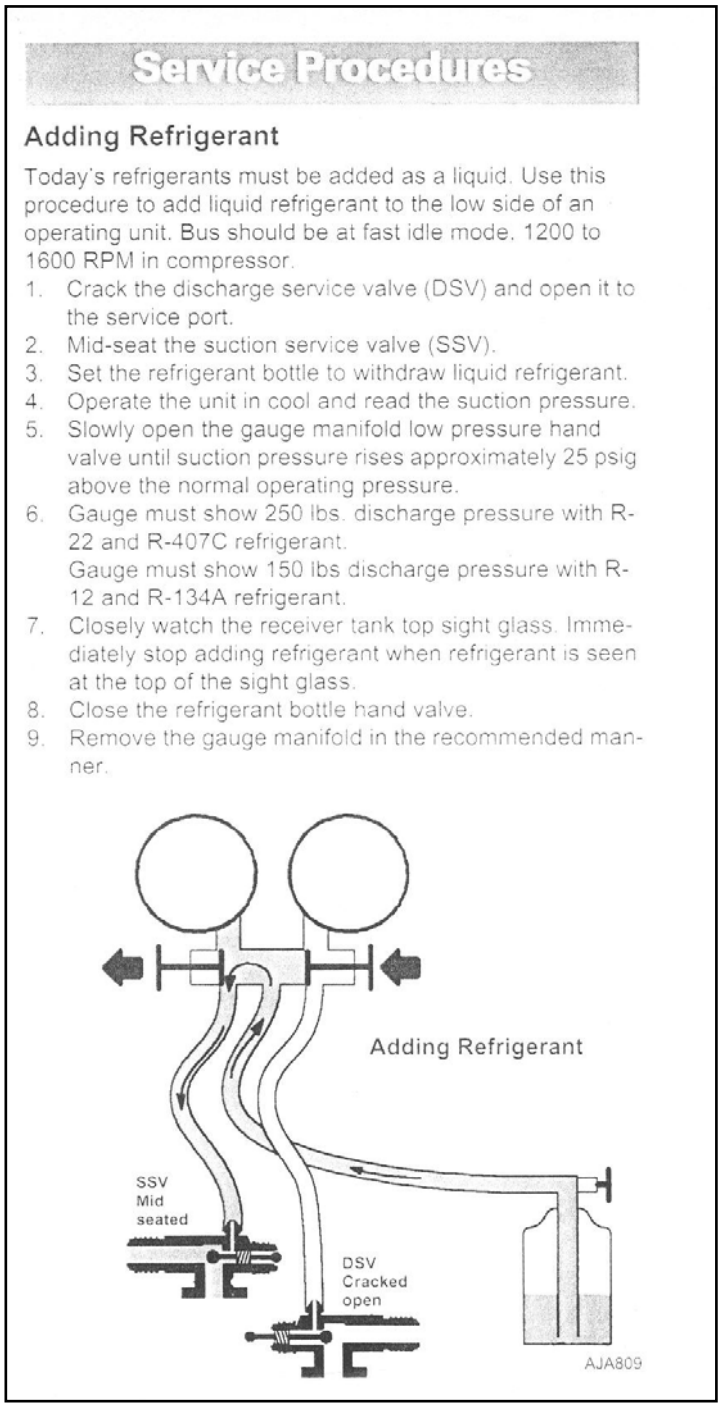
PROCEDURE:	STANDARD REPAIR TIMES MANUAL	**MODULE:**	2
DOC. NO:	Reference	**PAGE:**	5
PRINT DATE:	March 3, 2003		

MODEL	SRO NO.	HOURS	OPERATION
VII	**0039**	**1.0**	**Air Bellows (Rear) – Remove and Replace (each)** 1. Support air suspension and bus chassis. 2. Drain air from bellows. 3. Remove air line. 4. Remove upper and lower mounting bolts. 5. Replace bellow. 6. Check for leaks.
VII	**0040**	**1.2**	**Rear Wheel Bearing Repack (each)** 1. Loosen slack adjuster. 2. Remove axle nuts, wedges and axle. 3. Remove wheel bearing & retaining hardware. 4. Remove wheels, drum, and hub as an assembly. 5. Remove ABS exciter ring and inner wheel seal. 6. Wash both bearings in approved solvent. **NOTE:**Do not spin dry with compressed air. 7. Inspect and clean wheel bearing races in hub assembly. 8. Inspect wheel bearings for wear or damage. 9. Repack wheel bearings with approved grease (use bearing packer for best results) 10. Install inner bearing into hub. 11. Install new inner wheel seal. 12. Reinstall ABS exciter ring. 13. Slide wheel drum and hub assembly over axle tube. 14. Install outer wheel bearing and bearing retainer hardware (torque to specs) 15. Install axle and retaining hardware. 16. Re-adjust slack adjuster.
VII	**0041**	**2.8**	**Rear Hub Overhaul (each)** 1. Remove wheels and drum from hub assembly on bus. 2. Remove axle assembly and loosen slack adjuster. 3. Remove wheel bearing axle lock nuts and locking plate and washer. 4. Slide hub off axle tube. 5. Remove ABS exciter ring and inner wheel seal. 6. Remove inner bearing. 7. Drive out inner & outer wheel bearing races. 8. Wash hub in approved solvent and check for damage and cracks to hub. 9. Drive in new inner and outer bearing races (races must fit tight) 10. Grease pack new bearings. 11. Install inner bearing and new inner bearing seal. 12. Reinstall ABS exciter ring. 13. Inspect and replace any damaged wheel or axle studs. 14. Install hub over axle tube. 15. Install outer bearing washer locking nuts and plate (torque to specs) 16. Install axle shaft with new seals and gaskets. 17. Install wedges, nuts and torque to specs. 18. Install drum and screws. 19. Install wheels and lug nuts (torque to specs) 20. Readjust slack adjuster. Note: Add 0.1 hour for each lug or axle stud replaced.

FIGURE 1 Sample page from a bus manufacturer's SRT manual (*6*).

This information may be provided in the maintenance manuals, service bulletins, and other related documentation of original equipment manufacturers (OEMs) and their equipment suppliers. Figure 1 shows a sample page from a transit bus manufacturer's maintenance manual, complete with time standards (*6*). OEMs do not automatically provide this information, so it should be requested as a part of the transit agencies' procurement specifications.

The OEM also typically provides detailed information in regard to the recommended PM programs. In their service manuals, subsystem suppliers provide similar information on the subsystems. Sometimes these service recommendations are included in the OEM manual; other times they are provided separately. Figure 2 shows a sample page from a heating, ventilating, and air conditioning (HVAC) supplier's service manual (*7*). It should be noted



Service Procedures

Adding Refrigerant

Today's refrigerants must be added as a liquid. Use this procedure to add liquid refrigerant to the low side of an operating unit. Bus should be at fast idle mode. 1200 to 1600 RPM in compressor.

1. Crack the discharge service valve (DSV) and open it to the service port.
2. Mid-seat the suction service valve (SSV).
3. Set the refrigerant bottle to withdraw liquid refrigerant.
4. Operate the unit in cool and read the suction pressure.
5. Slowly open the gauge manifold low pressure hand valve until suction pressure rises approximately 25 psig above the normal operating pressure.
6. Gauge must show 250 lbs. discharge pressure with R-22 and R-407C refrigerant.
   Gauge must show 150 lbs discharge pressure with R-12 and R-134A refrigerant.
7. Closely watch the receiver tank top sight glass. Immediately stop adding refrigerant when refrigerant is seen at the top of the sight glass.
8. Close the refrigerant bottle hand valve.
9. Remove the gauge manifold in the recommended manner.

FIGURE 2 Sample page from an HVAC manufacturer's manual (*7*).

that times are not included in that manual. Many transit agencies supplement OEM manuals by producing their own internal documentation tailored to their operating conditions. At some agencies, these documents are readily available to maintenance personnel, and they are used as the basis of the operating/union agreements. Most of the responding transit agencies provide hard copies of the process-and-procedures documents. Some larger agencies provide them on computer terminals on the shop floor, thereby facilitating access to other pertinent manuals or bulletins for the maintenance employees. The computer-provided information is easier to keep updated, and the maintenance shop employees can then either view the material or print a copy for posting at their workstations.

Some transit agencies have also investigated information from other sources, such as the federally required testing program at the Pennsylvania Transportation Institute's

Bus Testing and Research Center in Altoona. This center may also be doing more extensive testing of transit buses in the future, which could lead to an additional source of information. Also, some agencies have looked outside of the transit industry to the heavy-duty automotive and the truck industry, such as the Technology and Maintenance Council of the American Trucking Association, for information on flat rate manuals.

Developing Standards

There are a variety of methods that public transit agencies have used to implement productivity standards. A few transit agencies have the capabilities to use formalized IE procedures to establish their own SRT. One engine manufacturer's SRT are developed by determining repair times for each step of the procedure and totaling these times to complete a quality repair (*3*). Metro Transit of King County, Washington, modified the formalized IE process by using a sampling method whereby various mechanics were monitored following a detailed job description and various related activities. The standard time was calculated as the average of the sampling.

Some agencies rely on manipulations of their own historical information to set standards. A few have used other agencies' information and procedures and then adapted them to their own operating requirements. Figure 3 shows a sample page from a Milwaukee County Transit System (MCTS) Process Sheet, which is posted on the TRB AP035 (was A1E16) Transit Fleet Maintenance WebBoard and can be downloaded and then modified to meet individual transit agency requirements.

03/24/2003

MILWAUKEE COUNTY TRANSIT SYSTEM
Maintenance Department Process Sheet

DESCRIPTION: Starter Remove & Replace **COACH:** New Flyer

DIVISION: All Locations **WORK CODE:** 1809 D **TIME STANDARD:** 1.0 Hr

PARTS AS REQUIRED:

Starter 4000 - 4145	#090-09-004	Starter Gasket	#158-34-003
Starter 4200 - 4750	#090-12-001		

SAFETY CAUTIONS:
Engine temperature should be less than 130 degrees. Always shift battery disconnect switch to the "off" position to avoid injury from accidental engine starting while servicing. When starting engine be sure that transmission lever is in the"Neutral" position and hand brake is set.

QUALITY CHECKS:
Start engine to check function and for fluid leaks. Torque values: mounting nuts: 181-226 ft. lbs, small connections: 16-30 ft. lbs, larger connections: 20-25 ft. lbs.

STEP BY STEP METHOD:

1.) Shift battery disconnect switch to "off" position.
2.) Disconnect power cable and ground cable from starter.
3.) Disconnect all wires from solenoid.
4.) Support starter and remove the (3) bolts which secure it to the flywheel housing.
5.) Remove starter and set aside. Fill out and attach unit exchange tag to starter.
6.) Get rebuilt starter and new gasket.
7.) Scrape old gasket material off of starter mounting surface. Place new gasket over (3) studs, spray with "Copper-Coat" to prevent slipping.
8.) Support starter and install the (3) bolts that secure it to the flywheel housing. Caution: Be careful not to tear or dislodge new gasket.
9.) Connect all wires to solenoid. Connect power cable and ground cable to starter.
10.) Torque the (3) mounting bolts to 181-226 ft. lbs. Torque the small connections to 16-30 ft. lbs. Torque the larger connections to 20-25 ft. lbs.
11.) Shift battery disconnect switch to "on" position.
12.) Start engine to confirm function.

CAUTION: Check for transmission fluid leaking past gasket with engine running. Will only happen if gasket had been torn or old gasket material was not scrapped off clean enough.

13.) Close all hatches. Return coach to service. Clean up area. Report to supervisor for next assignment. Punch off work code 1809 D.

Page 1 of 1

FIGURE 3 Sample of an MCTS process document with time standard.

Quality Assurance

There is a large range in the organization, methods, and parameters used by transit agencies to provide quality assurance. Some transit agencies have a formal quality assurance group, whereas others use supervision to measure quality. Some agencies use sophisticated data-gathering techniques, whereas others rely on supervisory inspections of the vehicles, as they leave the maintenance facility, as a way to gather data.

Each agency monitors a customized list of parameters using its own methodology to assess quality. The following items are typically monitored to provide quality indices: road calls, bus changes, pull-ins, defects found during preventive maintenance inspections (PMIs), driver-reported defects, repeat failures, frequency of repair or rebuild, and other miscellaneous maintenance work items where mileage and costs can be measured.

Incentive Plans

Many agencies have an employee incentive plan that provides rewards for attendance, innovative ideas, high-quality work, safe operation, and other goals that improve productivity and quality of life, such as achieving safety program goals. The majority of the agencies have programs for attendance and safety, and some of the incentive plans are included in their union contracts. Incentive programs may improve employee morale and teamwork. Figure 4 provides an example of the inclusion of an incentive program within the Houston Metro union contract.

Materials Issues

Many agencies use pre-pulled kits or bills of material (BOMs) that allow the maintenance staff to perform assigned work without having to individually obtain the parts. Kits or BOMs are designed to include every part that is needed to repair or rebuild a given component. Some agencies have developed kits or BOMs, or they have provided all of the replacement items required for a PM program in the immediate work area. Kits or BOMs allow the maintenance employees to concentrate on a given maintenance task without losing time to retrieve parts. They help the maintenance employees to efficiently complete their work assignments, as well as eliminate the time and potential distraction resulting from an employee leaving the assembly area. Kits or BOMs can be assembled by in-house staff, usually at a lower pay rate than for a journeyman mechanic, or they can be purchased directly from a vendor. Figure 5 shows an example of the materials that can be found in a maintenance kit or BOM. In addition, a properly assembled kit or BOM eliminates a judgment call on whether or not a part is acceptable. However, some agencies would rather have an experienced mechanic decide on the reuse of certain parts.

Documented Productivity Improvement Programs in Transit Agencies

As mentioned earlier, *NCTRP Synthesis of Transit Practice 4: Allocation of Time for Transit Bus Maintenance Functions* was published in August 1984 (*4*). CTA and Metro Transit in Seattle were the two highlighted transit agencies, owing to the large amount of documentation available. CTA still tracks the information, but has made some minor updates to the system over the years. Both agencies monitor the maintenance work, but have not enforced the time standards. They now emphasize training and quality as indicators of productivity improvement.

Metro Transit discontinued the use of repair time in its standards in the mid-1980s. That agency still uses the monitoring system but has dropped the time standards. Its efforts are now focused on training improvements and efficiency. Maintenance goals are focused on making the correct repair the first time and eliminating "come backs." Maintenance task completion time is recorded to track maintenance costs, but the information is not used for productivity improvement measurement. Instead, overall safety and effectiveness of the repair are emphasized rather than the speed of completing a given task.

CTA has continued to use the times that were determined during the IE review of various maintenance tasks. Processes and procedures incorporating time standards have been improved and are still used. However, in the late 1980s, the number of employees in the department responsible for that program was reduced. A limited staff was retained to prepare internal bulletins and work procedures, but there is no longer sufficient time for updating or adding new bulletins with time standards. There have also been recent objections by unions to some of the time standards. For these reasons, new maintenance procedures for recently purchased buses were not studied, and only approximate times were loosely established. CTA is now beginning to review these processes and procedures as well as the time required to accomplish the maintenance work.

Since the early 1990s, the MTA NYCT has been the industry leader in setting standards and has worked with the unions to agree on the productivity procedures. The process for the development of standards at MTA NYCT is illustrated in Figure 6. (The abbreviations are explained in Abbreviations and Acronyms, following the Bibliography.) The procedures in these agreements include the approval of the SRT, establishment of a joint committee of union and management to develop SRT, selection of an indepen-

1. If on-time performance during each 6 months is:

   92.1% = .75% of 6 months total earnings
   87.9% = .50% of 6 months total earnings
   Below 87.9% = No cash payment

   On-time performance will be measured by the current standard established by Metro's Transit Operations Department.

2. If vehicle miles between service interruptions during each 6 months is:

   5,299 miles = .75% of 6 months total earnings
   5,058 miles = .50% of 6 months total earnings
   Below 5,058 miles = No cash payment

   This performance standard is a substitute for the former "miles between road calls" standard. The "miles between road calls" standards took into account only mechanical road calls. This new standard concerns service interruptions. Service interruptions include operational interruptions in service (greater than one minute due to the operators' ability to properly operate equipment and maintenance interruptions due to equipment problems.

3. If accidents per 100,000 vehicle miles during each 6 months is:

   1.00 = .75% of 6 months total earnings
   1.05 = .50% of 6 months total earnings
   Above 1.05 = No cash payment

4. If employee influenced complaints per 100,000 passenger boardings during 6 months is:

   15.80 = .75% of 6 months total earnings
   16.60 = .50% of 6 months total earnings
   Above 16.60 = No cash payment

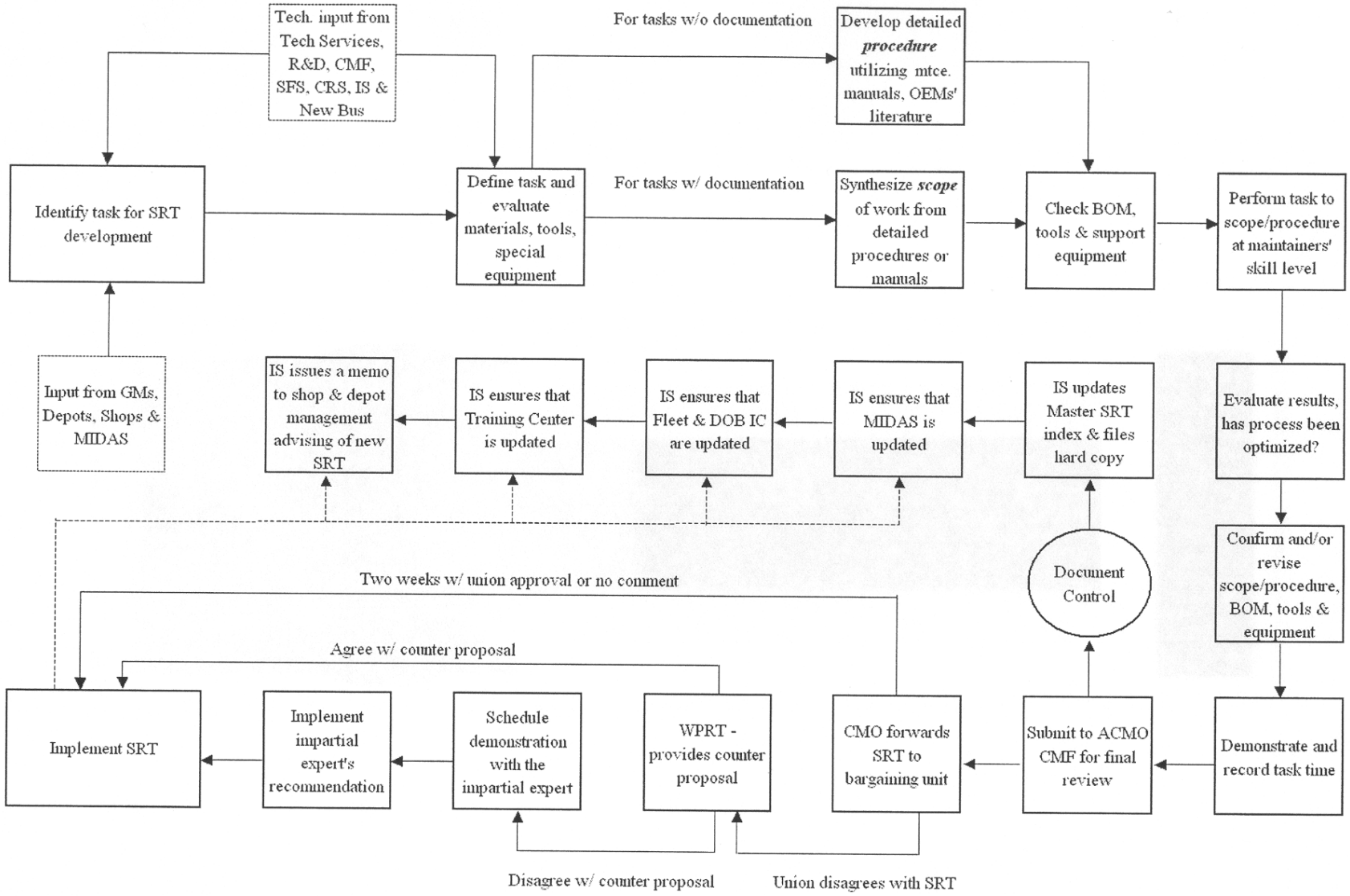
3. System-wide Performance Cash Payments (as in the past, applicable to full-time employees).

   A. Full-time Bargaining Unit employees will be eligible for cash payments every 6 months between August 1, 2002, and July 31, 2005 (i.e., August 1, 2002, through January 31, 2003; February 1, 2003, through July 31, 2003; August 1, 2003, through January 31, 2004; and February 1, 2004, through July 31, 2004; August 1, 2004, through January 31, 2005; February 1, 2005, through July 31, 2005); if (i) certain system-wide performance goals are met and (ii) if they are employed for the entire six-month period in question. The maximum possible payment if maximum system-wide goals are achieved will be 3% of the total six-month period earnings per employee.

FIGURE 4 Sample of Houston Metro's incentive program union contract.

```
REPORT ID : <DROPRPT2>                    NEW YORK CITY TRANSIT AUTHORITY                    PAGE :     1
REPORT DATE : 03/13/2003                    COMMODITY MANAGEMENT SYSTEM

                                                D R O P   R E P O R T                        03/13/2003
                                                ---------------------

                                          JOB : 00098            BOMID : RLF1999NOV


DROP NO:   98        SEQUENCE NO: 000000    DUE DATE:
DROP DESC.: FRONT RELINE NOVA 1999
              DROP DATE: 03/13/2003        BASE QTY:       1    TOT NO. ITEMS:    9     DROP FROM SR 059 TO SR 59 KITTING AREA

STOCK NO     U/M   ITEM DESCRIPTION                 QTY/KIT   ROS QTY
========     ===   ================               ========   =======

74-11-8001   SET   BRAKE BLOCK, FRONT, 1/16" OVER     2.00         2
80-67-0038   EA    BRAKE SLACK ADJUSTER, LEFT HAN     1.00         1
80-67-0039   EA    BRAKE SLACK ADJUSTER, RIGHT HA     1.00         1
80-83-0003   EA    CAMSHAFT, RH                       1.00         1
80-83-0004   EA    CAMSHAFT, LH                       1.00         1
86-67-0001   EA    CHAMBER, BRAKE, FRONT, STREET      1.00         1
86-67-0002   EA    CHAMBER, BRAKE, FRONT, CURB SI     1.00         1
86-67-0004   EA    DIAPHRAGM, FRONT BRAKE CHAMBER     2.00         2
92-80-2098   KIT   KIT, BRAKE, FRONT OR TRAILING     1.00         1
```

FIGURE 5 Sample of MTA NYCT material in a Kit/BOM.



* This flowchart does not include OEM or vendor developed SRTs. OEM SRTs and vendor warranty work resulting in the development of new SRTs are implemented directly in the shops and depots without involvement of the WPRT.

FIGURE 6 MTA NYCT SRT development process.

dent expert to resolve any disputed SRT, training provisions for staff who lack specific skill levels, reclassification of employees who cannot meet the SRT owing to a lack of mechanical aptitude, approval of flat pay rates for OEM-provided SRT, and adoption of a productivity incentive program (PIP) that pays employees a bonus for complying with the SRT. MTA NYCT is striving to have all maintenance actions covered by a formal procedure and established SRT. Because MTA NYCT is large and well staffed, it is likely to be successful. Many other agencies have shown an interest in improving productivity but do not have the resources to approach the success shown at MTA NYCT. Some smaller agencies have modified the information provided by the larger transit agencies and other sources to produce standards to achieve productivity goals. Others have developed standards using their own historical maintenance information.

NEW TECHNOLOGY

Electronic Diagnostics

Technology is progressing at a rapid rate, and the capabilities of electronic diagnostic systems are quickly responding. Many agencies stated that these electronic diagnostic systems have improved their troubleshooting productivity and the ability to ensure that repairs are done correctly the first time. Microprocessor and microcontrollers have the ability to control several bus functions and store data in memory to perform self-diagnostic functions. Electronic applications include engines, transmissions, HVAC systems, passenger doors, lighting, antilock breaking systems, multiplexing, destination signs, voice announcements, and other subsystems. In addition to extracting data to monitor the status of the various systems, the electronic controls are used to set parameters to automatically adjust the equipment. In an automatic transmission, for example, electronics are used to compensate for wearing clutch-pack discs and then trigger a fault code when the discs have worn down to a critical thickness.

Electronic controls have also reduced the need for manual tune-ups required on the mechanical engines. However, the addition of more complex systems and sensors to accomplish this task in turn makes the equipment more complex, which affects maintenance personnel. Although these systems have proven extremely reliable, they are not maintenance free. The equipment does fail from time to time, and basic electrical connections between these devices can also fail. In addition, maintenance personnel must be trained to use a computer or hand-held electronic "reading" device to download diagnostic codes and to perform the indicated repairs. However, when mechanics are properly trained in using this equipment, overall diagnostic time as well as repair and replacement time may be reduced. The capabilities of the electronic controls and diagnostic tools pinpoint the exact fault, which reduces the guesswork and time spent in replacing parts that are not part of the problem.

Some bus systems have built-in self-diagnostic capability that can be monitored as part of the system itself and that do not require an external reading device (i.e., fault codes are read off a screen mounted directly on the electronic control unit). Others use wireless technology to automatically upload diagnostic data to the transit agency while the bus operates in revenue service or as it enters the facility. *TCRP Report 43: Understanding and Applying Advanced On-Board Bus Electronics* has additional information on electronic systems and diagnostics (*8*).

Test Equipment

Manufacturers of electronic systems typically provide the necessary software and hardware (e.g., personal computers, hand-held readers, or personal digital assistants) to allow maintenance personnel to access data and identify faults and defective parts. Most transit agencies purchase the equipment when buying new buses. Each new generation of electronically controlled equipment may need the proper software for the system purchased. Laptop computers are extensively used to extract operating information, as well as to reprogram systems to better match operating requirements. Some agencies buy larger computers mounted in rigid cabinets to roll to the bus for diagnostic testing to prevent the damage and loss experienced with laptops.

Tools and Equipment

The OEM can also supply transit agencies with special tools to improve the productivity of the maintenance department. The bus manufacturers have worked with many transit agencies to develop such tools, along with appropriate procedures to help the maintenance department work more productively. Many agencies have, on their own, designed and built gauges, tools, and fixtures to reduce the time and maintenance staff required to remove and replace a given component. These in-house tools may also address the safety aspects of the maintenance action.

UNION AND MANAGEMENT ISSUES

Management Support

All of the agencies that responded to the survey and those that were later contacted strongly believe that improving productivity is important. The importance of the productivity program must be accompanied by a strong management commitment throughout the organization. All successful productivity programs occurred in organizations that completely endorsed total productivity improvement programs.

The productivity improvement goals were clearly defined and promoted by the all of the supervisory staff at those transit agencies. This process is not easy, and it takes a long time to develop a program that is supported throughout the agency. Continuous review and updating is also required for the program to remain successful. Programs that have not been successful most likely reflect a lack of total management commitment and a reluctance to address problems. In many cases, funding issues have hampered such programs. Resources could be dedicated to addressing these funding deficiencies, because spending for productivity improvement can yield future savings.

Union Involvement

For the productivity program to work, the union that represents the rank-and-file maintenance workers has to be involved. Obtaining union involvement and support is the most important part of implementing a successful productivity improvement program. Such a program should, from the start, be designed to effectively address and resolve union concerns involving its members. No program can be effective if not all the players are on the same team; therefore, the union must be a part of the team from day one. In a 1994 report, the American Federation of Labor–Congress of Industrial Organizations (AFL-CIO) promoted the partnership of labor and management. The last sentence of that document reflects the attitude that should be adopted:

> And the time has come for labor and management to surmount past enmities and to forge the kind of partnership, which can generate more productive, humane, and democratic systems in work organization (*9*).

From the beginning, there are many opportunities for union management and its members to have a voice in the productivity program. Advantages for union members should be stressed to the union managers. There are many opportunities for negotiations and the union and transit agency management must resolve any differences. For example, some agencies that do not use a strict time standard using IE procedures have worked out compromises with the union representatives to develop average times for work tasks. Managers and unions, when collaborating, should strive to use employee input as a source of information for improving the work environment, thereby allowing productivity improvements. Union managers can be convinced that agreements on repair times will provide productivity control, aid staffing forecasts for future budgets and special programs (rehabs and retrofits), and justify filling vacant job positions. MTA NYCT believes that it is important for transit agencies to consider the following:

- The current environment requires the public sector to be competitive with the private sector.
- Industry standards that can be applied universally become the benchmark for performance in a maintenance organization that is independent of economics.
- Therefore, if a task time (SRT) is the measure and it is done in appropriate equivalents, then one can characterize the constant with regard to local economies—that is, adjust for local prevailing wage rate.

Collective Bargaining Agreements

Almost all of the agencies reported that there are no restrictions on using time standards for maintenance work in their collective bargaining agreement. However, in follow-up discussions, many agencies stated that the union management was hesitant to discuss this issue.

A notable exception is seen at the MTA NYCT, where, since 1994, union and management have continually negotiated a productivity improvement partnership. Initial agreement terms included establishment of hourly SRT and a work procedure review team. Two team members were designated by the union and two members by management. A majority of the team was needed to make any recommendations. If there was no majority, the chief maintenance officer and a vice president from the union would propose a solution. The agreement also stated that any work savings could not lead to the reduction of existing employee levels or overtime work, but that the savings would be used to enhance the operating efficiency of the fleet. According to the MTA NYCT, the payback from this effort consists of the following:

- Public sector becoming competitive with private sector;
- Added job security for employees;
- Growth potential for the union;
- Warranty and vendor campaign work is performed in-house; and
- Increased “make or buy” decisions; for example, it would be cost-effective to rebuild more units in-house.

Furthermore, failure to meet a norm would not be the basis for disciplinary action in and of itself. In 1996, additional items were added to the labor agreement, including that the parties immediately implement 26 work items currently agreed on and that they continue to implement any new standards. An independent expert was appointed to resolve any disputed SRT. Implementation of SRT occurred weekly after agreement by the work procedure review team or at the direction of the independent expert. Existing standards may be improved. Additional training would be provided to any maintenance worker who lacks the specific skills and any such worker who is unable to meet the SRT with this additional training will be offered reassignment to

another position with no loss of pay. In 1999, the MTA NYCT agreement was supplemented with a Memorandum of Understanding (MOU) that used the flat rate times supplied by the OEMs. These flat rate times, where applicable, became the repair times for all maintenance functions, including troubleshooting and diagnostics. An effort was made to develop flat rate times for any maintenance work that does not have prescribed times.

The productivity improvement program was included in this MOU, and it pays a quarterly $600 bonus to any maintenance person who complies with the SRT by meeting the SRT on 90% of the tasks assigned during the first two quarters of the year. After the first two quarters, the maintenance person must achieve 95% compliance of the SRT to receive the bonus. In the fourth quarter of 2001, the hourly productivity improvement program pilot was first implemented at the Support Fleet Services division (nonrevenue vehicles—cars and trucks). In August 2002, the productivity improvement program was expanded to the two overhaul shops.

In addition, productivity improvement agreements, including a bonus program, were implemented with the two supervisory unions. Because the supervisors are the first line of supervision for the maintenance employee, they are a key element in making productive staff assignments and monitoring the SRT compliance rate. Those supervisors are members of two different unions, as agreed on by the unions and management through the MOUs. A form was designed for management to use to evaluate the supervisors, through a two-part process. The first part is a daily monitoring of the supervisors' strategic planning of all resources under his or her control and the consequent productive assignment of the hourly employees. The second part includes a set of performance standards that supervisors need to meet to qualify for a monetary incentive. Supervisors will be responsible for helping to identify, counsel, and train employees who fail to meet normal productivity and quality standards. They have also been given the goal of ensuring that the employees meet the 95% compliance of the SRT on each shift and that time lost owing to lack of parts, unavailable tools and equipment, or the unavailability of buses should not exceed 5% of the productive time of any shift. Meeting the goal requires the supervisor to properly plan and manage his or her resources to ensure that exceptions to the SRT are eliminated. The supervisory bonus is the same as the hourly bonus and was implemented systemwide in October 2002 (*10*) (see Appendix C for additional details).

Separate Agreements

Most of these agreements would be supplemental to the existing union contract and may be included in a new contract when negotiated. The MTA NYCT used separate agreements to initiate the productivity improvement program that set SRT for maintenance jobs and generated bonuses for the employees. No other agency reported the use of supplemental union agreements.

Performance Indicators

All responding transit agencies use some type of performance indicators to provide performance feedback. Miles between road calls, total cost per mile, and labor cost per mile are three of the many indicators that are used. Performance indicators vary from agency to agency. Other indicators that are used by transit agencies include road calls by fleet and system, cost per bus, repeat failures, making pullouts, fuel and oil mileage, and number of PM procedures completed on schedule. The definition of a road call usually conforms to the FTA guidelines, but each agency has modified the definitions to meet its unique operating environment, making it difficult to compare data among agencies. Some agencies have collaborated with the unions and employees to publish the performance indicators. Many agencies use the indicators to stimulate internal competition between operating locations and as employee incentives. Use of performance indicators, detailed by individual transit agencies, is summarized in chapter three.

TRAINING CONCERNS

Electronic Diagnostics

With the advent of microprocessor-controlled equipment and the use of electronic diagnostics, the process for troubleshooting is better controlled. Training requirements have changed, but not necessarily decreased. Today's maintenance person must be properly trained in the use of the diagnostic test equipment, failure codes, and fault analysis, to efficiently diagnose a failure and replace the required parts. The larger agencies have a separate training department with dedicated trainers who spend time in a classroom and on a bus to teach the details of the electronic testing equipment. Most agencies use the OEM training programs for either on-site or factory training. Some agencies use the OEM trainers to train the agency trainers, who then train the maintenance employees. Some agencies use supervisory staff to train maintenance employees in the proper use of the electronic equipment. Proper training can result in efficient diagnostics and expedite the return of the bus back to service. Almost all of the responding agencies noted that electronic diagnostic equipment has reduced the guesswork and time of a formerly painstaking process that relied heavily on the experience of the maintenance person. If an agency is not experiencing productivity improvement with the use of electronic diagnostic equipment, its training methods should be reviewed. *TCRP Synthesis 44: Training for On-Board Bus Electronics* details the maintenance

training needed to properly troubleshoot the electronic systems (*11*).

Training Programs

Most agencies have a qualification process to ensure that maintenance employees have mastered the training program. Employees must pass the course, show that they can do the work efficiently, and meet quality standards before they are certified to do the work. A few properties have encouraged their mechanics to become certified by the National Institute for Automotive Service Excellence (ASE). Current ASE certification is available for trucks, but TCRP is working with ASE to develop a bus certification testing program (TCRP Project E-6).

New training programs are initiated or updated when new buses arrive on the agency's property. At most agencies, the bus manufacturers and the suppliers of major components provide training for the maintenance staff. Some larger agencies use the OEM training to train the trainers. In their manuals, most of these manufacturers include a flat rate time for warranty maintenance repair work, a rate that may be incorporated into the training process. In such instances agencies have found that it is helpful to request flat rate times in new bus procurement specifications. (Sample SRT are shown in Figure 1.) Many agencies include some type of repair times in their training programs, but those times are used only as a guideline. Individual agencies should carefully review their training programs to determine whether they wish to include maintenance repair times. Retraining on tasks that have been modified with improved processes, procedures, parts, and new tools should also be considered.

Performance Goals

Almost all the agencies emphasize performance goals in training. It is imperative for management and union employees to be aware of, and support, the goals. Road-call goals are considered a sign of the quality of work performed, especially in the PM inspections. Productivity is measured by completing the PM inspections within the standards. All of the responding transit agencies use a variation of similar measurements, such as mileage per service interruption (road call) and times to complete PMIs. Others use road calls broken down by fleet and system, cost per bus, repeat failures, making pullouts, fuel and oil mileage, number of PMIs completed within scheduled mileage, and labor cost per mile. For some agencies, the repair times to accomplish a given task are used as a performance goal, whereas other agencies use the same parameter only as a guide. If an agency uses the standard as a goal and the employee consistently fails to meet the standard, a manager will first discuss the problem with the employee. Repeated failures will lead to retraining and finally progressive disciplinary measures. Agencies that use the standard only as a guide usually communicate that the standard is something to strive for and that there need not be any compromising of quality and safety. Ultimately, employees must be closely monitored and given feedback when problems occur.

QUALITY ISSUES

Most transit agencies aggressively monitor work quality. Many of the agencies that responded to the questionnaire emphasized that quality is the primary goal when addressing employee productivity. Respondents reported that monitoring quality is the most important task, and many agencies have a separate quality assurance department or use first-line supervision for this purpose. Setting time standards and monitoring productivity is secondary to instilling a quality mindset among management and all employees.

The information scrutinized by transit agencies to monitor quality also provides insight into the efficiency of the maintenance practices and can be further developed into productivity measurements. For example, the review of road calls according to miles operated between service interruptions may give the transit agency a picture of the effectiveness of their PM programs and repair maintenance programs. Many agencies also monitor the rebuild life of various components and compare mileage, duty cycle, and hours with those of new components, as well as with what other transit agencies are experiencing. Such information can be used for deciding whether to continue performance of the maintenance work in-house, purchase something new, or send the work to a vendor.

Monitoring short-component-life data should be used to prompt a review of that component to find the cause of the failure. Remediation of the problem and determination of the correction must include a review with the employee involved, materials used, and maintenance procedure used. Doing so may mean updating and revising training, using new parts or materials, revising new bus specifications, updating the procedure, and designing new tools and test equipment for the task.

Performance monitoring systems are essential for developing productivity and quality improvements. The agency's performance monitoring systems can be validated with the data provided by the transit industry by telephone, e-mail, and the APTA and TRB Webboards.

Failure to maintain or update a productivity improvement program will cause it to become irrelevant, and eventually it will be abandoned. Improvement must be continuously studied and implemented. A comment made at the

end of a report on transit agency productivity improvement, by using the shortest possible processing time rule, has particular relevance to this synthesis: "Another lesson to be read into all of this is that no solution is permanent, and must be either 'maintained' or updated if it is to yield long term results" (*12*).

UPDATE ON RELATED SYNTHESES

TCRP Synthesis 22: Monitoring Bus Maintenance Performance

The purpose of this 1997 synthesis (*13*) was to summarize a sampling of approaches that transit agencies and one private truck fleet use to monitor maintenance performance. Traditional monitoring approaches are covered, along with more sophisticated approaches. This synthesis covered the key issues that must be considered when measuring bus maintenance performance. It noted that each agency had a different approach to monitoring maintenance performance. Furthermore, it provided details on the transit agencies that are using sophisticated computer systems to monitor productivity, the production of formal documented work standards, and the use of SRT. The agencies chosen for review tended to have a large fleet and significant union involvement. Improvements in maintenance productivity were emphasized.

NCTRP Synthesis of Transit Practice 4: Allocation of Time for Transit Maintenance Functions

Mentioned previously, this 1984 synthesis (*4*) reviewed the use of standard maintenance job times (work standards) for transit bus maintenance at two transit agencies. The time–work studies were performed almost 20 years ago and are very dated. Some of the problems documented in this study surfaced because SRT were being used and documented for the first time within the agencies. Management changes and problems inherent in the systems prohibited the agencies' abilities to update the standards and to use them for productivity improvements. Both agencies have since reduced their use of SRT as a productivity tool and are currently using those SRT as a guide.

CHAPTER THREE

TRANSIT AGENCY PROGRAMS AND ISSUES—CASE STUDIES

This chapter summarizes responses by selected transit agencies to the survey questionnaire for this synthesis. Some properties have moved forward in improving maintenance productivity, whereas others have delayed their programs for one reason or another. The systems described in this chapter vary in size, climate, operating conditions, and union affiliation. Some use repair times as a standard, but most use them only as a guide. All of these agencies have widely different PM programs and maintenance repair programs, and all have goals they use to monitor productivity and quality.

MILWAUKEE COUNTY TRANSIT SYSTEM

Introduction

MCTS provides transit services for Milwaukee County, Wisconsin. A private contractor, Milwaukee Transport Services, Inc., operates the service. It has a fleet of approximately 500 buses. Milwaukee has been establishing formal documented maintenance practices with time standards. Its PM program is based on a 6,000-mi interval. There are three operating locations, one main shop facility for large maintenance work, and a fully equipped paint shop. All maintenance employees are represented by the Amalgamated Transit Union (ATU).

Development of Work Standards

Milwaukee has been developing work standards for PM programs and many other repair and rebuild functions, including SRT, for many years. It uses IE procedures to establish time standards for its process sheets (standard work procedures). The SRT are used only as a guide for the foreperson monitoring the work, to ensure that the employees are working within an acceptable range. A supervisor will consult with an employee who consistently fails to meet the goal. MCTS has reviewed the SRT provided by the OEM and uses them only as a guide. MCTS prefers to include more detail when developing its standards than does the OEM.

MCTS's PM inspections have been allotted 2 h using two different classifications of mechanics, thereby requiring four inspections per day by the two different mechanics. Any necessary repair work found during the inspections is assigned to other mechanics, using a work order report. All work is reported on the individual employee's time card on a job-by-job basis. Job codes have been set up for each job assignment. This information is then transferred to a computer database, where the data can be used to compare the cost of in-house repairs with the cost of work by outside vendors. A recent bus painting program successfully improved productivity by reducing the time to paint by 50%. Paint products and equipment were selected on the basis of cost comparison data provided by completed paint jobs. The program compared job data that indicated reduced job time when superior paint products and equipment were used. MCTS has an advantage in that most of its buses are supplied by the same manufacturer and are equipped with similar equipment options.

MCTS maintenance personnel use electronic diagnostic equipment to successfully reduce problem identification times. They do not use kits but maintain the parts in storage racks located in the component rebuild areas, making it easy to obtain the necessary parts. The mechanic decides when a part is to be reused. The MCTS process sheet provides the information on all other parts that are to be replaced. MCTS has also developed special tools to assist mechanics in performing their jobs in a safe, cost-effective, and efficient manner.

MCTS has been posting its process sheets on the TRB WebBoard under the heading of Process Sheets, which are available to all members of the WebBoard to use as a guide for their own agencies.

Productivity Agreement with Labor

MCTS is a private company. Its collective bargaining agreement with the local ATU does not have any wording that addresses the use of time standards to be used in performance of maintenance work.

Monitoring of Productivity and Compliance

The supervisor monitors employees working under his or her jurisdiction to verify the quality of work and completion of the assigned work within the appropriate time standards set for the work assigned. Time standards are used as a guide when management is discussing productivity with an employee who has not met these standards. A meeting with management and the employee usually resolves any problems that may have occurred.

Road-call mileages are broken down by fleet and systems. Other work processes (time and quality) and goals have been set for each area and are monitored for compliance. For example, brake mileage for each fleet, cost per mile by fleet and labor hours, miles traveled per person-hours worked, and fuel economy by fleet are monitored (see Figure 7 for details).

METROPOLITAN TRANSPORTATION AUTHORITY NEW YORK CITY TRANSIT

Introduction

MTA NYCT has documented detailed and formal maintenance procedures and practices, which include standard

Cost Comparison on Using New Brake Drums Versus Cutting the Used Brake Drums

COST OF INSTALLING NEW BRAKE DRUMS

Based on 2002 Brake Jobs

Bus Series	# Rear		Bus Series	# Front	
4000's	150		4000's	57	
4200's	4		4200's	4	
4300's	80		4300's	52	
4400's	49		4400's	6	
4500's	0		4500's	0	
4600's	1		4600's	0	
TOTAL	284	Rear Brake Jobs	TOTAL	119	Front Brake Jobs
	568	New Rear Drums---(2 per axle)		238	New Front Drums---(2 per axle)
	$97	Cost per Drum		$74	Cost per Drum
	$55,096	**Total Cost---New Rear Drums**		**$17,612**	**Total Cost---New Front Drums**

Total Cost---Buying New Front and Rear Brake Drums **$72,708 a year**

COST OF CUTTING USED BRAKE DRUMS

Percentage of Drums That Could Be Cut	Total	Cost To Cut Used Brake Drum	
Rear Brake Jobs---standard linings =	190	$38.06	per hour
Rear Brake Jobs---oversize linings =	32	x	
% of rear brake drums cut:	**14.4%**	0.75	hrs
Front Brake Jobs---standard linings =	95	$28.55	
Front Brake Jobs---oversize linings =	8	$1.45	material handling charge
% of front brake drums cut:	**7.8%**	**$30.00**	per brake drum

Cutting and Buying Rear Brake Drums		Cutting and Buying Front Brake Drums	
	Cutting-		Cutting-
568	rear brake drums	238	front brake drums
14.4%	% of drums that can be cut	7.8%	% of drums that can be cut
82	# of drums that can be cut	18	# of drums that can be cut
$30	cost to cut each drum	$30	cost to cut each drum
$2,460	Total Cost---Cutting Rear Drums	$540	Total Cost---Cutting Front Drums
	Buying-		Buying-
486	# of drums that can not be cut	220	# of drums that can not be cut
$97	cost of new rear drum	$74	cost of new front drum
$47,142	Total Cost- New Rear Drums	$16,280	Total Cost-New Front Drums
$49,602	**Total Cost-Cutting and Buying Rear Drums**	**$16,820**	**Total Cost-Cutting and Buying Front Drums**

Total Cost- Cutting Used & Buying New Brake Drums **$66,422 a year**

Summary:	**Total Cost---Buying New Front and Rear Brake Drums =**	**$72,708 a year**
	Total Cost---Cutting Used and Buying New Brake Drums =	**$66,422 a year**
	Cost Savings:	**$6,286 a year (2002 nos.)**

Note: There are hidden costs associated with cutting used drums that are hard to measure that need to be taken into account (assigning a machinist to cut drums, less road calls with new drums, liability factors with used drum...

FIGURE 7 MCTS's cost comparison for brake work.

times. MTA NYCT has the largest fleet in North America, with more than 4,800 buses. The buses are maintained in 22 depots and 4 major repair facilities. There are three hourly worker unions and two supervisory unions: ATU Locals 726 and 1056, the Transport Workers Union Local 100, Subway Surface Supervisors Association, and Transit Supervisors Organization, respectively. MTA NYCT employees perform approximately 10,000 different maintenance activities, and they have developed a comprehensive strategy for maintenance productivity.

Development of Work Standards

In the early stages of the program, MTA NYCT used the same system developed in other transportation organizations, which consisted of the application of standards, methods, and procedures to obtain high-quality and efficient repairs. MTA NYCT's strategy involved the development of SRT for the maintenance procedures unique to MTA NYCT transit vehicles. An internal industrial standards group was created to develop work standards for frequently performed maintenance activities with the use of IE procedures and work sampling data. The objective was to provide credible and equitable labor time and standards and procedures for the maintenance work. The result was a controlled list of industrial standards and procedures, along with times required to accomplish given tasks that met the appropriate safety, quality, reliability, functionality, and appearance requirements.

MTA NYCT requires OEM SRT in its bus specification requirements on bus orders and uses that information for comparison purposes. The agency also uses data from other transit agencies, bus testing programs, and industry groups, such as APTA and the Technology and Maintenance Council of the American Trucking Association. That information is available to all maintenance personnel.

MTA NYCT maintenance personnel use electronic diagnostic equipment to reduce troubleshooting time. MTA NYCT also uses kits/BOMs for most work performed in its overhaul and unit rebuild shops. Kits/BOMs have greatly improved productivity by reducing setup time and waiting time for parts at the storeroom. In the small unit shop, kits/BOMs are provided on a daily basis and delivered to the individual employee's workbench before the start of his or her shift. The kits/BOMs contain 100% replacement parts and eliminate the need for the employee to sort out and retrieve parts from bins. MTA NYCT has also developed special tools to facilitate safety and efficiency.

Productivity Agreement with Labor

MTA NYCT successfully negotiated productivity improvements with the hourly workers unions in successive contracts from 1994 through 1999. Contracts include approval of SRT, a joint committee of union and management to develop SRT, an independent expert to resolve any disputed SRT, training provisions for employees not at specific skill levels, methods for reclassifying employees who cannot meet the SRT owing to a lack of mechanical aptitude, approval of OEM flat rate SRT, and adoption of a PIP that includes a bonus for complying with SRT (see Appendix C for more details).

Monitoring of Productivity and Compliance

MTA NYCT uses electronic databases to track and report time spent to complete tasks. An employee's supervisor initiates a work order for a given job and then tracks the work performance on that job. Each SRT has a unique code, and the numbering system is common to all directives and bulletins distributed by MTA NYCT. Compliance is monitored daily by both management and the union. Supervisor productivity is monitored biweekly in a comprehensive performance evaluation.

METROPOLITAN TRANSIT AUTHORITY OF HARRIS COUNTY, TEXAS

Introduction

This agency, known as Houston Metro, operates 1,460 buses. It has six operating facilities (one is operated by a contractor) and one main overhaul shop. Houston Metro has a formal documented maintenance program that uses time standards. The PM program is based on a 3,000-mi interval. There is one maintenance employee union: Transport Workers Union Local 260. Houston Metro has 30 bus maintenance job position categories, not including cleaners, that use union employees.

Development of Work Standards

Houston Metro uses historical data to develop maintenance repair programs with standard times. It has also developed a unique PM program in which all the inspections are categorized into 8-h (full-shift) jobs. At Houston Metro, an inspection task includes reporting defects, minor repairs, and additional PM inspection items. If the maintenance employee completes the inspection in less time than the 8-h standard, inspections and minor repairs may be done earlier than programmed to fill the 8-h time (full-shift) interval or the employee may be asked to finish out the day on running repairs. However, if the employee does not complete the PM assignment within the 8-h interval and does not provide justification for not completing the inspection, the employee faces progressively tougher disciplinary action.

Houston Metro is currently evaluating in-house work by comparing labor, material, and warranty costs with those of vendor's work. It has completed evaluation of the paint jobs and found efficiencies that reduced the preparation and painting times. New target goals for a complete paint job for its 45-ft and 60-ft buses have been established (see Appendix D for additional details).

Component rebuild times also have been established by using historical data for labor and material costs. The shop provides the same warranty as does an outside vendor on rebuilt components. If a shop-built part fails within the warranty time that an outside vendor would provide, the operating location is credited the cost for the replacement part.

OEM manuals, service bulletins, and parts catalogs are required in the contracts from the OEM in a computerized format and are kept updated. All maintenance documentation, including in-house maintenance bulletins and procedures, is readily accessible by all employees by means of computers in the shops and at the operating locations. Currently, there are not enough data to evaluate productivity improvements derived from the use of electronic diagnostic equipment. Kits are used for productivity improvements during PM inspections, brake relines, and small component rebuilds.

Productivity Agreement with Labor

There is nothing in the Houston Metro union agreements that restricts the use of SRT for any maintenance work. The agreements allow for a systemwide performance cash payment for meeting productivity goals every 6 months. All of the systemwide performance indicators must fall within two ranges for employees to receive a 3% or 1.5% bonus, and both maintenance and operations must meet all the goals for any bonus to be paid. The four indicators are on-time performance, miles between service interruptions, accidents per 100,000 mi, and employee-influenced complaints per 100,000 passenger boardings. An individual employee can receive a bonus for perfect attendance or having no on-the-job injuries for an entire year (see Figure 4 for the contract wording for these incentive programs).

Monitoring of Productivity and Compliance

Standards are upgraded yearly or when a new bus fleet is delivered. Computer-generated reports that track labor hours and material costs are compared with historical data. If the goals are not met and no acceptable reason is given, progressively tougher disciplinary measures are taken. If an employee has a problem that delays completion of the work and the supervisor validates it, a new work order is provided to address the additional work.

Road-call data are categorized by operating location, fleet, mechanical defect, shop defect, vendor warranty, and fleet defect. These performance indicators are used to monitor the quality of work and adherence to work standards. Houston Metro also prepares an Annual Rebuild Forecast report, where estimates of labor and material are determined for all components that will be rebuilt in the next year. These estimates are also used to monitor productivity by comparisons with actual labor and material costs.

Buses are always parked in the same parking slot when not in service, allowing an operator to drive the same bus every day. This practice facilitates pride of ownership, better reporting of defects, and increased employee responsibility for the bus.

ORANGE COUNTY TRANSPORTATION AUTHORITY

Introduction

OCTA operates transit service in Orange County, California, with more than 570 buses and three operating facilities. One facility has a section dedicated to rebuilding components. OCTA's PM program is based on a 6,000-mi interval. The agency does have formal documented maintenance procedures, but it has not developed time standards for those procedures. All of the agency's maintenance workers are classified as Journeyman Mechanics and are members of the International Brotherhood of Teamsters.

Development of Work Standards

OCTA has established a PM program that includes a detailed bus inspection. The inspection for a diesel bus takes approximately 8 h. Any defects found are repaired later through a work order. OCTA is in the process of finalizing the inspection program for liquid natural gas (LNG) buses, which have been recently added to the fleet. The agency estimates that the inspection of LNG buses will take 10 to 12 h, primarily because of the complexity of the fuel system.

OCTA has determined, but not formally published, informal time standards for other repair work. The agency has established average repair times for some component rebuilds by averaging historical work records. Procedures and time standards are reviewed with each new bus order. During an employee's training, the time to complete each repair is discussed, but it is used only as a guide. OCTA provides its maintenance staff with hard copies of the procedures and is installing computers on the shop floor to enable the staff to access maintenance manuals, parts manuals, bulletins from the OEMs, and OCTA's own internal

documents. OCTA encourages all its mechanics to achieve ASE certification and provides educational reimbursement to encourage continuing education (see Appendix E for union contract agreements). OCTA uses electronic diagnostic equipment to reduce troubling shooting labor hours, and it reported that the diagnostic equipment produces higher quality diagnosis and less equipment downtime. OCTA also uses kits to expedite brake component repair and rehab.

Productivity Agreement with Labor

Nothing is written in the union agreement that restricts OCTA from setting repair times for maintenance work. However, concerns have been expressed about setting time standards for any maintenance work. Therefore, time standards are considered a guide or estimate of how much time should be spent on a maintenance job. During training, employees are given the average time expected to complete an assignment during training, but the given time is not considered a standard.

Monitoring of Productivity and Compliance

OCTA has established monthly maintenance goals: miles per gallon for diesel for both 40-ft and articulated buses and for LNG for all buses. Goals for the following parameters are also set for each operating location: (1) cost per mile, (2) miles per quart of oil, (3) attendance (including overtime), (4) spare buses on hold, (5) miles between road calls, and (6) on-the-job injuries. Goals have also been established for six measurable indicators that are used for the employees' bonus program: (1) miles per gallon, (2) cost per mile (not including fuel and overhead), (3) attendance, (4) spare buses on hold, (5) miles between road calls, and (6) warranty recovery. The yearly average bonus is $650 per person. OCTA averages 10,000 mi between road calls and the average maintenance cost per mile is 46 cents (labor and material cost to maintain the bus only). OCTA also monitors brake mileage, transmission overhaul mileage, engine overhaul mileage, and fuel mileage. All goals are summarized, compared, and posted every month at all operating locations (see Figure 8 for details).

Supervisors currently monitor the work as it is progressing. They determine if there is a problem and will counsel employees to resolve any issues. Additional training or counseling is used if no justifiable reason for the longer time can be verified. Discipline measures are used as the last resort.

OCTA is developing a quality assurance group that will provide analysis and research. The group will also monitor vehicle performance, parts usage, labor utilization, campaigns, vendor performance, and other maintenance performance aspects.

KING COUNTY METRO TRANSIT—SEATTLE

Introduction

Metro Transit in King County, Washington, operates more than 1,320 buses. The fleet includes a mixture of diesel-powered (more than 770) and trackless trolley buses, operating out of seven facilities and one component supply center. There are two unions: ATU Local 587 for hourly staff and ATU Local 17 for supervisory staff. Metro Transit uses documented maintenance procedures and does have some time guidelines for those procedures. Quality is its main concern, and the agency has a quality assurance group.

Development of Work Standards

In the 1980s, Metro Transit was highlighted in *NCTRP Synthesis of Transit Practice 4: Allocation of Time for Transit Bus Maintenance Functions* (*4*). Metro Transit's study used an independent consultant to develop time standards for a portion of the bus fleet and then used those same standards on another bus fleet. The component life of that bus fleet was poor, and the buses were in need of substantial maintenance. The use of the time standards on those buses was unsuccessful, and further use of any of the elements in the study continued to be problematic and controversial. Therefore, the study and resultant time standards were discontinued.

Recent efforts concentrate on training and on making the correct repair the first time. Safety and effectiveness of the repair is emphasized over speed. Because current vehicles are equipped with complex components, efficiency can no longer be measured only by speedy work. Metro Transit focuses on the work environment necessary for effective repairs, which includes providing shop tools and support equipment, lighting, expedited parts, and accurate manuals. If the shops are appropriately equipped and the employees are properly trained, effective and timely repairs will occur.

Electronic diagnostic equipment has not yet provided productivity improvement increases. Metro Transit provides hard copies and computer access to OEM manuals and bulletins, as well as internal service and maintenance bulletins. Kits for brake relines and engine and transmission overhauls have been used for more than 20 years. The agency has standardized drive train components to improve productivity and has reduced the average vehicle age to below 8 years. Metro Transit has PM, quality assurance, and training and failure analysis programs that provide effective productivity improvements.

MAINTENANCE STANDARDS AND PERFORMANCE INDICATORS

FY 2002-03

TOTAL DEPARTMENT

EFFICIENCY	Goal	Jul-02	Aug-02	Sep-02	Oct-02	Nov-02	Dec-02	Jan-03	Feb-03	Mar-03	Apr-03	May-03	Jun-03	YTD
Miles Per Gallon - 40 ft. Diesel	>3.85	3.90	4.00	3.81	4.01	4.16	4.22	4.18						4.04
Miles Per Gallon - Articulated	>2.50	1.96	2.45	2.12	2.38	2.61	2.65	2.65						2.40
Total Miles Per Gallon - Diesel	>3.75	3.53	3.71	3.48	3.68	3.88	3.98	3.90						3.74
Total Miles Per Gallon - LNG	>1.50	1.49	1.48	1.51	1.51	1.49	1.51	1.56						1.51
Miles Per Quart - Oil	> 415	853	1,147	1,879	1,861	1,851	1,626	1,882						1,586
Cost Per Mile														
Overall		0.64	1.30	1.12	1.15	1.29	1.35	1.44						1.18
Fleet Direct	< 0.44	0.43	0.48	0.47	0.49	0.47	0.43	0.46						0.46
Attendance	> 97%	98.2%	98.6%	98.7%	98.3%	98.5%	98.4%	98.7%						98.5%
Overtime - Contract	< 1.5%	1.3%	0.0%	1.2%	0.0%	5.3%	0.3%	1.4%						1.4%
Overtime - Control	< 3.0%	6.3%	5.7%	8.1%	8.0%	17.0%	8.1%	8.7%						8.8%
EFFECTIVENESS														
Spares on Hold: 5:30am	< 90%	30.9%	37.5%	38.3%	33.4%	36.3%	38.5%	37.3%						36.0%
2:30pm	< 90%	32.5%	40.7%	40.5%	35.3%	38.2%	37.3%	39.2%						37.7%
Daily Bus Down for Parts		11.5	12.2	12.0	11.0	11.0	11.5	8.5						11.1
Miles Between Road Calls														
Large Bus: Valid Mechanical	> 9,000	9,349	10,066	8,611	11,360	9,222	10,092	9,642						9,763
Large Bus: Non-Mechanical	> 6,500	7,365	9,159	9,127	9,411	8,799	8,892	8,301						8,722
BUS ACCIDENTS														
Number of Accidents		68	57	43	93	62	61	76						66
Percent of Fleet		13.2%	11.1%	8.4%	18.1%	12.1%	11.9%	14.2%						12.7%
Labor Cost		6,630	4,382	2,680	6,446	3,118	4,155	2,997						4,344
Parts Cost		5,395	2,173	1,687	4,939	2,307	6,592	4,680						3,968
Total Cost		12,025	6,555	4,368	11,385	5,424	10,747	7,677						8,311
Vandalism Repairs	< 9,000	5,215	15,593	12,278	7,905	15,984	19,868	16,082						13,275
On-the-Job Injury Hrs Lost	< 2.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%						0.01%
Lost Time Occurrences		1	1	0	0	0	0	0						0
Non-Lost Time Occurrences		2	0	1	2	2	1	3						2

Overall Cost Per Mile is includes all Maintenance expenditures except Facilities and Training.(Source: IFAS)
Fleet Direct Cost Per Mile includes Parts and Labor costs to maintain fixed route buses. (Source: MAPS and IFAS)

FIGURE 8 OCTA's maintenance standards and performance indicators.

Productivity Agreement with Labor

There is nothing in the union agreement that restricts the use of repair times. However, there is language in the agreement that prevents outsourcing of significant maintenance work.

Monitoring of Productivity and Compliance

Metro Transit monitors miles between road calls and cost per mile and compares that information with budget standards on a monthly basis. The agency also measures labor hours per 1,000 revenue miles by fleet type. Furthermore, Metro Transit also monitors the time it takes to perform typical repetitive repairs, as indicated on work order records. If an employee takes an extraordinary amount of time for a repetitive or routine repair, the lead shift mechanic will be questioned. Metro Transit will not question the employee at the first instance of such a problem. If the same discrepancy recurs with the same employee, training records and work history will be reviewed before questioning the employee. The employee is then interviewed to determine if any supportive or corrective measures are needed. The interview is of a nondisciplinary nature.

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

Introduction

The Massachusetts Bay Transportation Authority (MBTA) has a fleet of more than 900 buses in 8 operating facilities and 1 main bus repair facility. The International Union of Machinists and Aerospace Workers represent MBTA's maintenance workers. MBTA uses documented maintenance procedures, but it does not have time standards for those procedures. The agency has average times for most maintenance practices, although the times are not used for setting goals and standards, but rather as a guide. MBTA would have to negotiate with the union to use time standards for performance measurement.

Development of Work Standards

MBTA has had maintenance procedures and policies for many years. These procedures and policies are modified annually and when new buses enter service. PM programs allow 4 h for a 6,000-mi inspection and 8 h for a 12,000-mi inspection, with additional work done during the latter. Other maintenance work uses repair times established from historical transit industry information sources only as a guide. The allotted hours for component rebuilding tasks have been agreed on by a foreperson, union representative, and management. These parameters are used for every rebuildable component for monitoring productivity, forecasting labor requirements, and justifying hiring.

In addition, an annual productivity study is conducted in the main repair shop for adjusting staffing. The study analyzes repairs and recommends whether to continue in-house repairs, contract repair work to outside vendors, or buy new equipment. The study bases its recommendations on manpower usage, cost, and demand levels from garages. If the price to outsource is 30% higher or lower than the in-house cost to repair, the study will recommend either outsourcing or purchasing a new component.

MBTA also focuses on a variety of practices that provide productivity improvements. The agency uses electronic diagnostics and hand-held electronic readers for faster failure resolution. Kits are used to improve productivity for the PM inspections, brake relines, engine rebuilds, and other component rebuilds. MBTA has improved training programs to update mechanical skills. Training programs also advise employees on the expected time to complete certain tasks. Furthermore, MBTA has implemented mid-life and life-extending overhaul programs that have had a positive impact on mechanical reliability, reduced failures, and improved quality of service and general safety.

Productivity Agreement with Labor

There are no restrictions in the union labor agreement on the use of repair times. If MBTA wanted to require that maintenance employees meet time standards, it would have to negotiate with the unions.

Monitoring of Productivity and Compliance

MBTA uses maintenance forepersons to provide quality inspection. The foreperson does not formally monitor the time it takes to complete a task, but is responsible for determining what problems may delay efficient completion. Productivity is measured by monitoring road-call mileage between failures. Road-call reports are broken down by fleet, assigned garage, and system. Maintenance costs are tracked on a cost-per-mile basis. Variations in this parameter can be investigated to ensure proper maintenance functions and cost control. These data can also be used to evaluate whether maintenance tasks should be outsourced.

MBTA also monitors maintenance areas on a monthly basis. A partial list of monthly reports includes the following data: number of bus inspections, inspections completed on time, and person-hours per task. Figure 9 shows a sample of a Monthly Bus Maintenance Report. MBTA quantifies its productivity programs according to increased reliability, cleaner emissions, and ability to meet increased availability without significant core fleet replacement.

COAST MOUNTAIN BUS COMPANY

Introduction

The Coast Mountain Bus Company operates in the greater Vancouver area of British Columbia, Canada, with a fleet of approximately 1,100 diesel and trolley buses, 6 operating facilities, and 1 main shop. Coast Mountain employees are represented by Canadian Auto Workers Union Local 2200.

Development of Work Standards

Previously, SRT for all major and minor repetitive tasks were developed in conjunction with the union, and the productivity program was presented in a very informal manner. Coast Mountain has recently made some organizational changes and initiated a new strategy for fleet maintenance. All procedures, practices, and standards are currently under review and are being documented. A process known as Activity Based Costing has been introduced to the overhaul shop and will soon be introduced into the operating maintenance area. The process compares the internal costs with outside vendor costs and, after a thorough review, makes a decision to keep the repair in-house or outsource the repair work. Coast Mountain provides hard copy and computer access of OEM manuals and their bulletins, along with Coast Mountain's internal manuals and bulletins on the shop floor. The employees can also access the trainers directly or through an intranet web page bulletin board to ask questions or provide suggestions on procedures and practices.

Coast Mountain has dedicated a portion of its budget to invest in special tools and equipment. Kits are used for some component results and other maintenance tasks. The agency is currently upgrading its training program and providing each employee with a minimum of 15 h of annual training.

Monthly Bus Maintenance Report
12/01/02 - 12/31/02

Assigned Facility	Albany(442)			Bartlett(443)			Fellsway(445)			Charlestown(449)			Quincy(452)			Lynn(453)			Cabot(455)			Everett	Total		
Bus Total	119			159			80			211			86			104			180			45	984		
Mileage	228,981			338,922			97,843			638,536			225,146			107,450			434,791			NA	2,071,669		
Mean Miles Between Breakdowns	2,726			4,035			3,763			5,068			8,659			1,761			3,535			NA	3,909		
Bus Availability(PM) %	87%			83%			79%			91%			90%			78%			91%			NA	86%		
Bus Drivers Seats Replaced	5			8			3			6			2			5			10			0	39		
Task	G	A	%	G	A	%	G	A	%	G	A	%	G	A	%	G	A	%	G	A	%	A	G	A	%
12,000 Mile Inspection	19	13	68%	30	40	133%	11	14	127%	46	47	102%	17	21	124%	21	12	57%	35	32	91%	0	179	179	100%
6,000 Mile Inspection	19	20	105%	30	37	123%	11	5	45%	46	54	117%	17	16	94%	21	13	62%	35	34	97%	0	179	179	100%
Winterization Check(Sept-Dec)	29	27	93%	43	4	9%	23	1	4%	25	1	4%	20	15	75%	26	23	88%	47	4	NA	0	213	75	35%
Summerization Check(Mar-June)	0	0	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	0	0	0	NA
State Inspection(10months)	0	7	NA	0	9	NA	0	2	NA	0	0	NA	8	0	0%	0	1	NA	0	0	NA	0	8	19	238%
Semi-Annual A/C Inspection	0	0	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	0	0	0	NA
Annual A/C Inspection	20	0	0%	19	0	0%	7	0	0%	38	0	0%	8	0	0%	12	0	0%	18	0	0%	0	122	0	0%
Engine	1	0	NA	3	1	NA	**	0	NA	4	0	0%	**	0	NA	**	0	NA	*	0	NA	0	NA	1	NA
Transmission	1	5	NA	3	2	NA	**	0	NA	4	1	25%	**	0	NA	**	4	NA	*	1	NA	7	NA	20	NA
Cooling Fan Hub Adapter Kit	*	0	NA	*	1	NA	**	0	NA	*	3	NA	**	0	NA	**	0	NA	10	0	0%	0	NA	4	NA
Alternator Belt Tensioner	*	0	NA	*	1	NA	**	0	NA	*	1	NA	**	0	NA	**	0	NA	10	0	0%	0	NA	2	NA
Radiator	1	0	NA	3	2	NA	**	0	NA	4	6	150%	**	2	NA	**	0	NA	*	0	NA	7	NA	17	NA
Platform Assembly, W/C Lift	*	4	NA	3	11	367%	**	9	NA	4	3	75%	**	1	NA	**	4	NA	1	4	400%	0	NA	36	NA
84-85 Series Bulkheads	**			**			2			1			2			1			**						
Steering Overhaul	1			3			**			4			**			**			*						
Suspension Overhual	1			3			**			4			**			**			*						
Brake Reline Rear	8	7	88%	18	22	122%	5	2	40%	26	29	112%	10	6	60%	9	7	78%	21	37	176%	0	97	110	113%
Brake Reline Front	3	4	133%	6	10	167%	2	2	100%	5	19	380%	4	2	50%	3	1	33%	7	13	186%	0	30	51	170%
Total Buses Completed	103	92	89%	164	148	90%	61	38	62%	211	170	81%	86	65	76%	93	70	75%	184	135	73%	14	828	732	88%

* Replacement on failure only.
** Equipment type is not assigned to facility.

G: Goal
A: Actual
%: Acutal/Goal *100%

FIGURE 9 Sample of MBTA's monthly maintenance report.

Productivity Agreement with Labor

There is nothing in the collective bargaining agreement restricting the use of repair times for vehicle maintenance work. Coast Mountain is currently in favor of formally using repair times as part of the work order system. Also, Coast Mountain is in the process of establishing a full-time committee to investigate the development and use of time-based standards, and it plans to invite union participation.

Monitoring of Productivity and Compliance

Coast Mountain monitors road calls by mean distance between failures. That information is compared with an established goal within an established annual work plan and budget. Each month, the following indicators are compared: number of tasks completed versus what was stated in the work plan, actual labor hours versus the standard time, actual material costs versus the budget, overtime versus the forecast, and attendance versus the plan. Each work order is reviewed to ensure that labor hours and materials compare with the standard procedure. Reports identify the average hours, materials, or costs on a given overhaul by component, fleet, or operating location. Reports can also identify how employees perform compared with other employees on a given overhaul or repair. There is a monthly analysis on failed components from road-call information. Coast Mountain analyzes the cause of the failure from the data in this report and then proposes a solution to reduce or eliminate it from future roads calls. In 1999, Coast Mountain determined that exterior lights were their major source

of road calls (17.3%). The agency replaced the incandescent bulbs with light-emitting diodes, except for headlights and backup lights. The replacement was completed in 2003, and exterior lights now account for only 4.3% of the road calls. Figure 10 shows data on this productivity improvement.

Failure Code & Description	Number of Failures	Failures as a Percentage of Total	KM per RC
0307 EXTERIOR LIGHTS	228	17.2 %	12,344
0102 WON'T START	101	7.6 %	27,865
0106 LOW POWER	42	3.2 %	67,008
0304 SIGNALS	37	2.8 %	76,063
0108 CHECK ENGINE LIGHT ON	35	2.6 %	80,409
0501 TRANS LIGHT ON	34	2.6 %	82,774
0684 DRIVER'S SEAT	34	2.6 %	82,774
0406 BRAKES NOISY	31	2.3 %	90,785
0663 REAR DOORS WON'T OPEN	30	2.3 %	93,811
2006 SICKNESS	29	2.2 %	97,046

Year To Date	Distance (KM)	RoadCalls (Count)	MDBF (KM/RC)
2000	2,814,322	1,326	2,122
1999	2,716,340	1,229	2,210
Difference	97,982	97	-88
% Change	3.61 %	7.89 %	-3.97 %

Failure Code & Description	Number of Failures	Failures as a Percentage of Total	KM per RC
0406 BRAKES NOISY	17	11.9 %	20,679
0390 FAREBOX - CUBIC	16	11.2 %	21,971
0102 WON'T START	9	6.3 %	39,060
0109 ENGINE SHUT DOWN	6	4.2 %	58,590
0307 EXTERIOR LIGHTS	6	4.2 %	58,590
0392 TPU - TICKET PROCESSING UNIT- FAREBOX	6	4.2 %	58,590
0663 REAR DOORS WON'T OPEN	6	4.2 %	58,590
0395 ELECTRICAL FAULT - FAREBOX	5	3.5 %	70,308
3019 SERVICING-MAINTENANCE RELATED	5	3.5 %	70,308
0668 DOORS SLOW/FAST	4	2.8 %	87,885

Year to Date	Distance (KM)	RoadCalls (Count)	MDBF (KM/RC)
2003	1,703,206	641	2,657
2002	1,526,600	683	2,235
Difference	176,606	-42	422
% Change	11.57 %	-6.15 %	18.88 %

Flyer 40'(D40)

FIGURE 10 Coast Mountain's reduction in road calls by converting to light-emitting diode lamps.

CHAPTER FOUR

CONCLUSIONS

The information supplied by the transit agencies in response to the synthesis questionnaire indicates that there is strong interest in continued maintenance productivity efforts as long as quality is prioritized. The questionnaire responses also emphasize the importance of senior management support for a productivity improvement program to be successful and that the commitment to the program must be communicated throughout the entire organization, including the union affiliations.

One of the most important items is the proper definition of standard repair times. Transit properties have varying opinions. A particularly effective definition quoted in this synthesis can be found in chapter two in the section on general methodology. Transit agencies have continued making productivity improvements over the years in an effort to continue to reduce costs.

The results of the survey provide helpful details to anyone interested in transit maintenance productivity. Smaller agencies, which do not have a large staff or extensive funding, can effectively use some of the information provided if permitted by their unions and collective bargaining agreements. There is much to be gained by sharing information among interested agencies. For example, some agencies have worked with their employees to develop unpublished productivity standards that can be easily adapted by other agencies. Agencies that are currently developing productivity improvements may be interested in the successful programs that have provided incentives for employees who meet new productivity goals.

The application of industrial engineering productivity improvement methods in public transit agencies during the past 20 years has provided the following guidelines:

- The use of a standardized process and procedure documents can be accomplished without sacrificing quality and can reduce costs if the staff is properly trained and equipped.
- Good documentation must be easily accessible to the maintenance shop employees. Transit agencies that do not have the staff to prepare maintenance procedures can use documentation provided by the original equipment manufacturers or other transit agencies. These documents can then be modified to meet the unique local operating conditions.
- Standard repair times and maintenance manuals for all subsystems, including component subsuppliers, should be requested in new vehicle procurement specifications.
- Initial training and continued retraining of maintenance staff with the use of the latest tools and equipment is necessary for the success of any productivity program.
- Union–management relations will have a major impact on any productivity improvement program. The union management and employees must be asked to participate in the development and implementation of the program, thereby establishing a partnership between transit agency management and the union.
- Performance goals must be set and published for all to see and understand. Such goals must be supported by a strong methodology for gathering and interpreting relevant data. Smaller agencies are moving from manual systems to computerized methods, whereas larger agencies are becoming increasingly sophisticated in using computers in the shop.
- The most significant performance indicators are based on road calls, premature failures, pullouts, scheduled work compared with unscheduled work, bundling of work, repeat failures, and inspections completed on schedule. Data should be monitored on a monthly basis to allow for different operating conditions and climate changes. Additionally, data analysis should focus on problem diagnosis as much as on performance monitoring. It is important that such information be accurate and timely.
- The older methods of troubleshooting with nonelectronic components depend on having a staff of very experienced employees to diagnose problems, which adds cost and time to the troubleshooting task. However, the use of electronic diagnostic tools has increased, as has the presence of complex electronic component controllers on newer vehicles. That situation allows less-experienced but properly trained employees to efficiently troubleshoot. Transit agencies may improve overall productivity by investing in such tools and the proper training in using them.
- The maintenance area must be efficiently organized with proper tools and equipment to facilitate vehicle movement and retrieving parts for varied maintenance tasks. The use of kits or bills of material for routine work and component rebuilding can improve efficiency. Consideration should be given to improving the workflow in the maintenance facility when designing a new facility or redesigning an existing facility.

- Furthermore, improvement should be continuously studied and implemented. Failure to do so will cause a productivity improvement program to become irrelevant and eventually be abandoned. This lesson is true for all of the systems and was used in full to improve their maintenance productivity.
- Finally, there are many resources available to the transit agencies. Among them are the APTA and TRB websites and webboards. There is also information available from the bus manufacturers and their suppliers, as well as from the trucking industry.

Many methods that have proved successful in various industries can be used to create and refine productivity improvement programs. However, since the early 1990s, no major studies have been funded that review the application of these methods to transit agency maintenance productivity. There is a renewed need to fund studies on maintenance productivity and apply the findings. The economic benefits that result will prove increasingly necessary for the vitality of the industry.

Some suggestions for future studies related to this synthesis include:

- Cost–benefit analysis of implementing standards.
- Review of productivity improvement programs used in the trucking, aircraft, and European transportation industries.
- Collective bargaining agreement issues on the use of standards in performance measurement.
- Employee benefits and reimbursements/incentives for productivity.

REFERENCES

1. Mathewson, M.H., in *Industrial Engineering Handbook,* 2nd ed., H.B. Maynard, Ed., McGraw–Hill, New York, N.Y., 1963, pp. 1–18.
2. Herzog, D.R., *Industrial Engineering Methods and Controls,* Reston Publishing Company, Inc., Reston, Va., 1985.
3. *Standard Repair Times C Series Engines,* Bulletin No. 3666030-01, Cummins Engine Company, Columbus, Ind., 1993, pp. 1–4.
4. Inaba, K., *NCTRP Synthesis of Transit Practice 4*: *Allocation of Time for Transit Bus Maintenance Functions*, Transportation Research Board, National Research Council, Washington, D.C., Aug. 1984, 25 pp.
5. Haenisch, G.C. and F.G. Miller, "Increasing Productivity in Bus Maintenance Function," *Proceedings of American Institute of Industrial Engineers Spring Conference*, 1976.
6. *Standard Repair Times Manual*, Orion Bus Industries, Ltd., Mississauga, Ont., Canada, Mar. 3, 2003.
7. *Diagnosing Thermo King Bus Air Conditioning Systems*, Manual TK 51066-3-MS, Thermo King Corporation, Minneapolis, Minn., Oct. 2000.
8. Schiavone, J., *TCRP Report 43: Understanding and Applying Advanced On-Board Bus Electronics,* Transportation Research Board, National Research Council, Washington, D.C., 1999, 107 pp.
9. Stepp, J.R. and T.J. Schneider, "A Model for Union—Management Partnerships," *Perspectives on Work*, Vol. 1, No. 2, 1994, pp. 54–57.
10. Walsh, J., et al., *Productivity Incentive Program-Managers' Guide,* MTA New York City Transit, New York, Sep. 2002.
11. Schiavone, J., *TCRP Synthesis of Transit Practice 44: Training for On-Board Bus Electronics,* Transportation Research Board, National Research Council, Washington, D.C., 2002, 71 pp.
12. Martin-Vega, L.A., "SPT, Data Analysis, and a Bit of Common Sense in Bus Maintenance Operations: A Case Study," *AIIE Transactions*, Vol. 13, No. 4, Dec. 1981.
13. Schiavone, J.J., *TCRP Synthesis of Transit Practice 22*: *Monitoring Bus Maintenance Performance,* Transportation Research Board, National Research Council, Washington, D.C., 1997, 48 pp.

BIBLIOGRAPHY

Centeno, G., *Repair Time Standards for Transit Vehicles—Final Report,* Project BC137-RPW032, Florida Department of Transportation, Tallahassee, Sep. 24, 2002, 49 pp.

List, G. and M. Lowen, "Bus Maintenance Performance Indicators: Historical Development and Current Practice," *Transportation Research Record 1140*, Transportation Research Board, National Research Council, Washington, D.C., 1987, pp. 30–44.

Maze, T.H. and A.R. Cook, "Theory and Practice of Transit Bus Maintenance Performance Measurement," *Transportation Research Record 1140*, Transportation Research Board, Washington, D.C., 1987, pp. 18–29.

McGlothin Davis, Inc., in association with Corporate Strategies, Inc., *TCRP Report 77*: *Managing Transit's Workforce in the New Millennium,* Transportation Research Board, National Research Council, Washington, D.C., 2002, 154 pp.

TCRP Research Results Digest 13: Leveraging Information for Better Transit Maintenance, Transportation Research Board, National Research Council, Washington, D.C., Nov. 1996, 21 pp.

ABBREVIATIONS AND ACRONYMS

ACMO	assistant chief maintenance officer
ASE	National Institute for Automotive Service Excellence
ATU	Amalgamated Transit Union
BOM	bill of material
CMF	central maintenance facility
CRS	Central Road Support Service (road call response)
CTA	Chicago Transit Authority
DOB IC	Department of Bus (MTA NYCT) Internal Information Website
Fleet (NYCT)	Internal website for bus maintenance-related manuals, directives, policy instructions, etc.
GM	general manager
Houston Metro	Metropolitan Transit Authority of Harris County, Texas
HVAC	heating, ventilating, and air conditioning
IE	industrial engineering
IS	industrial standards
LNG	liquid natural gas
MBTA	Massachusetts Bay Transportation Authority
MCTS	Milwaukee County Transit System
Metro Transit	King County (Washington) Department of Transportation
MIDAS	Maintenance Information, Diagnostics, and Analysis for Surface (Oracle Database)
MOU	Memorandum of Understanding
MTA NYCT	Metropolitan Transportation Authority New York City Transit
NCTRP	National Cooperative Transit Research Program
OEM	original equipment manufacturer
OCTA	Orange County Transportation Authority
PIP	Productivity Incentive Program
PM	preventive maintenance
PMI	preventive maintenance inspection
R&D	research and development
SFS	Support Fleet Services (nonrevenue fleet maintenance)
SRT	standard repair times
WPRT	work procedure review team

APPENDIX A

Survey Questionnaire

TCRP Project J-7

Synthesis Topic SE-02

MAINTENANCE PRODUCTIVITY PRACTICES

Questionnaire

Name of property: _____

Name(s) of respondents and title(s), phone and fax number(s), and mailing and e-mail address(es):

_____
_____
_____
_____
_____
_____

Purpose of this survey: For a number of years, transit properties have been developing practices whereby maintenance practices would become more productive and efficient. Many different methods and procedures were tried to accomplish this task. The outcome of this effort is that some methods have been successful while others could only be classified as "dismal failures." In the current economic climate, transit properties are feeling pressure to be more productive and efficient with fewer dollars. This pressure must translate into productivity improvement and gains in efficiency. Maintenance department budgets are typically one of the largest components of the total operating cost of a transit system. As a result, the maintenance budget tends to be a target for cost cutting when the property's total budget is reviewed. Therefore, it is imperative for the transit properties to improve the productivity and efficiency of its maintenance forces. Given this situation, it is the intent of this synthesis to gather information from transit properties that have developed successful productivity improvement programs and to gain insight into those properties' practices and procedures.
When the survey is completed please send to:

Frank Venezia
Lea+Elliott, Inc.
1240 Iroquois Drive
Suite 402
Naperville, IL 60563
or Fax to:
630-548-4120

<u>Please provide the following information for heavy-duty transit buses 30 feet or longer only</u>.

1.0 Fleet Information

SEE CHARTS ATTACHED AT END OF THIS QUESTIONNAIRE.
NOTE: ONLY INCLUDE FLEETS OF 30 FEET OR LONGER
Make additional copies of charts as needed.

2.0 Maintenance Practices and Procedures

2.1 Do you have a formal documented maintenance practice and procedures that includes standard times that the maintenance staff is to meet? Yes ___ No ___
If yes, do these practices and procedures include a written procedure describing the process along with a time standard? Yes ___ No ___
If yes, please provide list of the maintenance practices and procedures standards. (Attach list if too long.)

_____
_____
_____
_____

2.2 Do you have a quality assurance group to ensure that the practice and procedures are producing a quality product? Yes ___ No ___
If yes, provide details on their job duties to ensure practices and procedures are followed.

_____
_____
_____
_____

2.2.1 List preventive maintenance programs and describe what is done in each program/level. (Attach list of maintenance programs.)

_____
_____

2.2.2 What is your schedule for a preventive maintenance program? (Attach list of maintenance program schedules.) Is it done by mileage, calendar days, or engine hours/average speed?

_____
_____

2.2.3 Is productivity and work quality measured? Yes ___ No ___
If yes, provide details using list under 2.2.1. _____

_____
_____

2.2.4 What is the classification of personnel and union affiliation, and what level of training is required?

_____
_____

2.2.5 How do you measure productivity and quality of these programs?

_____
_____
_____

2.2.6 Is there a standard time used? Yes ___ No ___
If yes, provide the list of preventive maintenance programs with corresponding time. (Attach list with standard times.) _____

2.2.7 Does this list include only inspection time or does it include diagnostics, repair, etc.?
_____

2.2.8 How often are these standard times reviewed and upgraded? _____

2.3.1 Do you have a list of major maintenance jobs such as brake reline, in-chassis engine repair, complete engine removal and replacement, transmission removal and replacement, destination sign reprogramming, fare box reprogramming, wheelchair lift/ramp removal and replacement, engine overhaul, transmission overhaul, destination sign overhaul, drive axle overhaul, front axle overhaul, wheelchair lift/ramp overhaul, etc., with hours allotted for doing this work? Yes ___ No ___
If yes, does this include troubleshooting (diagnostics), locating the bus, bringing it to the workstation, and physically doing the work itself? Yes ___ No ___
Do you do any individual component rebuild such as starters, alternators, air compressors, and differentials?
Yes ___ No ___

If yes, provide a list of maintenance repairs with information time standards, along with the classification of the repair personnel, their labor rates, union affiliation, and amount of training they are required to have. (Attach additional sheets as necessary.)
_____

2.3.2 Have you done any research in doing this work in-house or sending to outside vendors?
Yes ___ No ___

If yes, what was the result of your research?
_____

2.3.3 In developing time standards targets, did you work with the union management to get their concurrence?
Yes ___ No ___

What were the results? _____

2.3.4 Is there a collective bargaining agreement that restricts the setting of repair times for any maintenance work?
Yes ___ No ___
If yes, please provide details. _____

2.4.1 Does your property have a formal plan for midlife and life-extending overhauls?
Yes ___ No ___
Do the overhauls include standard time targets? Yes ___ No ___
If yes, list what is accomplished under each overhaul program and reasoning used for each program.

_____
_____
_____

If yes, are overhauls done in-house or at outside vendors? _____
_____
_____
_____

2.4.2 What other programs are used for major work on the bus? _____
_____
_____
_____

2.5.1 Do your maintenance personnel utilize the diagnostic capabilities on the newer buses?
Yes ___ No ___
If yes, can you show an improvement in productivity with it? Yes ___ No ___

If yes, give some examples of improved productivity. _____
_____
_____
_____

2.6.1 Does your property have a formal training program? Yes ___ No ___
If yes, provide details on how training is accomplished and how personnel are kept up to speed with new technology. _____
_____
_____
_____

2.6.2 Does your training include productivity goals and practices? Yes ___ No ___
If yes, provide information on this. _____
_____
_____
_____

2.7.1 Describe how the time standard targets are used to evaluate individual personnel and management performance.
_____
_____
_____

3.0 Operating Facilities

3.1 How many operating facilities do you have? _____

3.2 What is the classification of your maintenance personnel at these locations? List all qualifications including the training required. _____
_____
_____
_____

3.3 How many buses are based out of each shop? _____

3.4 Do you have a main shop? Yes ___ No ___
If yes, what is done at this shop and list the union and classification of the personnel and training required.

4.0 Road Calls

4.1 Do you use road calls as a measure of maintenance productivity? Yes ___ No ___
If yes, how is this accomplished? _____

4.2 What is your property's definition of a road call? _____

4.3 Are they broken down in relation to the fleet systems (engine, transmission, HVAC, ADA equipment, etc.) or other classifications? Yes ___ No ___
If yes, provide the breakdown. _____

5.0 Maintenance Productivity Programs

5.1 Are maintenance costs tracked on a cost per mile ___ or cost per labor-hour ___ basis? Provide your reasoning.

5.2 Are your costs broken down by individual fleet and components? Yes ___ No ___

If yes, provide the breakdowns. _____

5.3 Do you have a record keeping system in place to adequately track labor hours and material cost for each maintenance action? Yes ___ No ___

5.4 Have you tried to improve the cost per mile or cost per labor-hour? Yes ___ No ___
If yes, what methods did you use to lower costs? _____

5.5 Have you instituted any maintenance productivity improvement programs in the last few years? Yes ___ No ___
Have they been successful? Yes ___ No ___

If yes, please provide details of the programs. _____

5.6 Have they improved productivity and can it be quantified? Yes ___ No ___
If yes, describe the improvement. _____

If no, have they been modified to correct any shortcomings? Yes ___ No ___

5.7 Have you modified your training programs to keep your personnel up to speed on the new equipment and technology on the recently purchased buses? Yes ___ No ___
If yes, has this been successful in reducing labor-hours to troubleshoot and repair buses? Yes ___ No ___
If yes, describe the improvement. _____

5.8 Have you set productivity goals or targets (measurable numbers) for your maintenance practices?
Yes ___ No ___
If yes, please list them and the classification of the maintenance personnel that are impacted. _____

5.9 Have you provided kits for repair functions, or special tools and equipment to improve the productivity goals?
Yes ___ No ___
If yes, provide details. _____

5.10 Have you utilized any standards/procedures (such as OEM manuals, internal manuals/bulletins, etc.) to improve productivity of maintenance staff? Yes ___ No ___
If yes, what standards were used? _____

5.11 Are there any plans for future programs that can be shared with other transit properties? Yes ___ No ___
If yes, can you provide them for inclusion in this synthesis? Yes ___ No ___

5.12 Have there been programs in the personnel issues to improve attendance, job training, work ethics (productive time), quality of the work product, etc.? Yes ___ No ___
If yes, describe the program(s). _____

5.13 Have you compared your cost with any of your peers? Yes ___ No ___
If yes, were you able to reconcile the difference? Yes ___ No ___

Please fax the completed questionnaire by March 17, 2003, to 630-548-4120

Or mail to

Frank Venezia
Lea+Elliott, Inc.
1240 Iroquois Drive
Suite 402
Naperville, IL 60563

If you have any questions regarding this questionnaire, please contact
Frank Venezia at 630-548-5740

Thank You for Your Participation

TCRP PROJECT J-7
TOPIC SE-02
Maintenance Productivity Practices

Bus Manufac-turer	Model Number	Number of Buses	Delivery Date of Fleet	Average Mileage/Bus or Total Fleet Mileage	Average Operating Speed	Fuel Type	Bus Length—30 ft or longer only	Standard or Low Floor	Engine Manufac-turer and Model	Engine Horsepower Rating

Additional comments regarding other equipment options that are capable of diagnostic testing. _____

_____

_____

_____

_____

_____

_____

TCRP PROJECT J-7
TOPIC SE-02
Maintenance Productivity Practices

Bus Manufacturer	Transmission Manufacturer and Model	Number of Speeds	Retarder—Internal, External, or None	Transmission Fluid Type	Axles/Brakes Front Manufacturer/Type	Axle/Brakes Center (if applicable) Manufacturer/Type	Axles*/Brakes Rear (drive) Type and Mileage to Reline	Manufacturer Passenger Door Operator/Air or Electric

*Note whether single or tandem axle.

Additional comments regarding other equipment options that are capable of diagnostic testing. _____

_____

_____

_____

_____

_____

_____

TCRP PROJECT J-7
TOPIC SE-02
Maintenance Productivity Practices

Bus Manufacturer	Number of Passenger Doors/ Width	Electrical System Relays or Multiplex Manufacturer	HVAC Manufacturer Model	HVAC Controls Manual or Automatic	HVAC—Does It Have Electronic Diagnostic Capability	Destination Sign/ Manufacturer Type	Interior Electronic Signs/ Manufacturer/Type	Automatic Voice Annunciation Manufacturer/Type	Video Surveillance Cameras Manufacturer/Type

Additional comments regarding other equipment options that are capable of diagnostic testing. _____

_____

_____

_____

_____

_____

_____

TCRP PROJECT J-7
TOPIC SE-02
Maintenance Productivity Practices

Maintenance Information Bus Manufacturer	Front Axle Brakes—Mileage to Reline	Center (if applicable) Axles/Brakes Mileage to Reline	Axles*/ Brakes Rear (drive) and Mileage to Reline	Engine Miles to Overhaul	Transmission Miles to Overhaul	Fuel Mileage	Mean Miles Between Road Calls	Alternator Miles Between Overhaul	Starter Miles Between Overhaul	Lift/ Ramp Miles Between Overhaul*	A/C Compressor Miles Between Overhaul	A/C Alternator Miles Between Overhaul	Air Compressor Miles Between Overhaul

*Note whether lift or ramp.

Additional comments regarding other equipment options that are capable of diagnostic testing. _____

_____

_____

_____

_____

_____

_____

APPENDIX B

Condensed Summary of Survey Responses

Transit Agency	Fleet Size	Documented Maintenance Practices w/Standard Times	Quality Assurance	Productivity Measurement Programs	Union Affiliation	Determining In-House versus Out-Source	Restrictions in Collective Bargaining Agreement	Diagnostic Tools/ Improved Productivity	Training Program with Standards	Parts Kits or BOMs	Employee Incentive Programs
Milwaukee County Transit System	227	Yes—ongoing	Foreperson/ management	Yes	ATU	Yes	None	Yes/Yes	Yes	No—parts maintained in work area	Incentive program for safety
Metro Transit (Madison, WI)	207	Yes/no time standards	Supervisors	Yes	Teamsters	Yes	None	Yes/No	Yes/no time standards	No	None
MTA New York City Transit	4,800	Yes	Yes	Yes	ATU TWU	Yes		Yes/No	Yes	Yes	See details in chapter three
Pierce Transit (WA)	249	Yes/no time standards	No/use supervision	Some	ATU	Yes	None	Yes/Yes	Yes/no time standards	Yes	Pay for mechanical certification and incentive for safety and attendance
Orange County Transportation Authority (CA)	570	Yes/no time standards	Yes—reengineering this group	Yes	Teamsters	Yes	None	Yes/Yes	Yes/no time standards	Yes	Education reimbursement, encourage ASE certification, incentives for productivity
Metropolitan Transit Authority of Harris County (TX)	1,460	Yes	Yes	Yes	TWU	Yes	None	Yes/No	Yes/no time standards	Yes	Systemwide on-time performance, vehicle miles between service interruptions (see additional details in chapter three)
Massachusetts Bay Transportation Authority	900	Yes	Foreperson/ maintenance instructors	Yes	Machinist Union	Yes—yearly study based on manpower, cost, and demand	None	Yes/Yes	Yes	Yes	Looking at more outsourcing of work
Pace Suburban Bus Division of RTA (IL)	836	Documented procedures/no time standards	Foreperson/ superintendent	Yes	ATU/ Teamsters	Yes	None	Yes/Yes	Yes/no time standards	Yes	Send major work out for repair

Transit Agency	Fleet Size	Documented Maintenance Practices w/Standard Times	Quality Assurance	Productivity Measurement Programs	Union Affiliation	Determining In-House versus Out-Source	Restrictions in Collective Bargaining Agreement	Diagnostic Tools/ Improved Productivity	Training Program with Standards	Parts Kits or BOMs	Employee Incentive Programs
San Mateo County Transit District (CA)	321	Yes/no time standards	1 person and supervisors on each shift	Yes	ATU	Yes	None	Yes/Yes	Yes/no time standards	Yes—limited	Employee attendance
King County DOT/Metro Transit (WA)	1,320	Yes/no time standards	Yes	No—productivity Yes—quality	ATU	Labor agreement has clause preventing this	Outsourcing only, none for setting repair times	Yes/No	Yes/no time standards	Yes	None
Coast Mountain Bus Company, Vancouver, BC	1,100	Yes—under review	Yes	Yes	Canadian Auto Workers	Working on this with union	Working on this with union	Yes/No	Yes	Yes	Employee attendance
Suburban Mobility Authority for Regional Transportation (MI)	267	No	Yes	No	UAW	No	None	Yes/Yes	Yes/no time standards	Yes	None
Capital Metropolitan Transportation Authority (TX)	278	Yes/some time standards	Yes	Yes	ATU	Yes	None	Yes/no response	Yes/no time standards	Yes	PMIs 4 days/week 10 hours/day
Regional Transportation Commission of Southern Nevada (ATC)	302	Documented procedures—only a few time standards	Foreman	Yes—Average times	ATU	Yes	None	Yes/Yes	Yes/no time standards	Kits for PMI and brake relines	None
Indianapolis Public Transportation Corporation (IN)	116	Some documented, but no time standards	Foreman	Yes—under review	ATU	Yes	None, but union uses past practice	Yes/No	No formal program	Yes	Presently investigating
Golden Gate Transit	283	Some documented, but no time standards	Chief/ Lead Mechanics	Yes	Machinists Union	Yes	None	Yes/Yes	Yes/time standards as a goal	(no response)	Rewards for attendance and recognition program for outstanding work practices
Metro (Missouri–Illinois Metropolitan District)	168	Yes—documented, but no time standards	In process of setting up a program	Some—others under review	ATU	Yes	None	Yes/No	Formal program starting in July 2003/no times standards	No	Not at this time

Transit Agency	Fleet Size	Documented Maintenance Practices w/Standard Times	Quality Assurance	Productivity Measurement Programs	Union Affiliation	Determining In-House versus Out-Source	Restrictions in Collective Bargaining Agreement	Diagnostic Tools/ Improved Productivity	Training Program with Standards	Parts Kits or BOMs	Employee Incentive Programs
Regional Transportation District (Denver, CO)	957	Yes—documented, but no time standards	Yes	Yes—under development	ATU	Yes	None	Yes/Yes	Formal program/ no time standards under development	Yes	New attendance policy and performance code
Central New York Regional Transportation Authority	184	Yes—documented, but approximate time standards	Managers and shop foreman	Yes	ATU	No	Yes	Yes/Yes	No formal program/use OEM training	Yes	Incentive program for attendance and quality of work
Central Ohio Transit Authority	309	Some documented, but no time standards	Supervisor	Some	TWU	Yes	Yes	Yes/Yes	No formal program/use OEM training	Yes	Presently working on some
Southeastern Pennsylvania Transportation Authority	1,108	Yes	QA personnel and management	Yes	TWU	Yes	None	Yes/Yes	Yes	Yes	Incentive program for attendance. Also give commendations for good work performance
Connecticut Transit (Hartford)	392	Yes/no time standards	Foreman	Some	ATU	No union issues	None, but union will not allow	Yes/Yes	Yes/no time standards, only hire mechanics with 15 years experience	Yes	Reduced staffing and overtime hours with same amount of work done. ASE certification required. Perfect attendance program
Los Angeles County Metropolitan Transportation Authority	2,344	Yes	QA department	Yes	ATU	Labor agreement has clause preventing this	None	Yes/Yes	Yes	Yes	Engine rebuild line one mechanic builds engine; all parts are supplied to line. Mechanic has ownership in engine: improved efficiency

Transit Agency	Fleet Size	Documented Maintenance Practices w/Standard Times	Quality Assurance	Productivity Measurement Programs	Union Affiliation	Determining In-House versus Out-Source	Restrictions in Collective Bargaining Agreement	Diagnostic Tools/ Improved Productivity	Training Program with Standards	Parts Kits or BOMs	Employee Incentive Programs
Chicago Transit Authority	2,020	Yes—but not all have standard times	QA department	Yes	ATU shop has electrical workers, machinists, bus/truck mechanics, carpenters, welders, painters, tinners, and upholsterers	Yes	None	Yes/Yes	Yes	Yes	Presently working on employee safety program
Toronto Transit Commission	1,453	Yes/no time standards; informal times for planning only	QA group	Yes	ATU	Yes	None	Yes/Yes	Yes/no time standards	Yes	Program instituted to reduce absenteeism
Metro Transit, Minneapolis	905	Yes	Supervisors	Yes	ATU	Yes	None	Yes/Yes	Yes	Yes	None

APPENDIX C

MTA NYCT—Additional Standard Repair Times Information

The MTA NYCT has provided three additional documents that may be useful in clarifying what was summarized in this synthesis. The first document is the Industrial Standard Bulletin, "Explanation of Development of Standard Repair Times (SRT)." The second is a Job Study Report, Staten Island, April 21, 1999. The final one is the contract for both the hourly and supervisor's union contracts on the Productivity Incentive Program.

MTA NEW YORK CITY TRANSIT DEPARTMENT OF BUSES		
	INDUSTRIAL STANDARDS BULLETIN	Code:
	Subject: **EXPLANATION OF DEVELOPMENT OF STANDARD REPAIR TIMES (SRT)**	Date: 9/21/98 Page: 1 of 3
		Document Control Initials:

Application: All maintenance actions.

Purpose: To provide users with an explanation of how Standard Repair Times are developed and applied at NYCT.

General Information

New York City Transit's Standard Repair Times (SRT) are lists of work tasks (procedures) and the cumulative time required to perform the task. The procedures list the task required to ensure a vehicle; system or component is ready to return to service with a quality repair at the lowest possible cost and with minimum delay. A Standard Repair Time is equitable when the repair described in the procedure can be performed in a time less than--or equal to-the standard by a maintainer after he/she has performed that repair in a similar application at least once. Those SRTs that a particular maintainer performs more frequently will often require less time than the standard. Several procedures may be required to reflect accurately all the tasks actually performed to return a particular vehicle, system or component to service.

NYCT's SRT Objectives and Philosophy

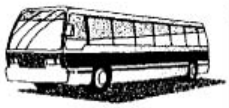
The purpose of this agreement is to standardize the performance of work that meets appropriate industry standards for safety, quality, reliability, functionality, and appearance within the SRTs.
The objective of NYCT's SRT program is to provide credible and equitable labor time standards and procedures for the maintenance service network,

A SRT is credible when the procedure accurately depicts the work that must be performed to accomplish a quality repair. A SRT is equitable when a task can be performed in a time less than--or equal to-the standard or norm by a maintainer.

To establish credible and equitable SRTs with suffricient flexibility to account for differences in complaints, failure, progressive damage, customer desires, etc., SRTs have been structured using the following considerations:

- What *must* always be done to repair the item.
- What *may* have to be done to repair the item depending on its condition.
- What parts may have to be removed to access the work.
- How difficult it is for the maintainer to reach the component even after any interfering application hardware has been removed.

The SRT process is designed to be applicable to all repairs on all types of buses, systems and components.

MTA NEW YORK CITY TRANSIT DEPARTMENT OF BUSES		
	**INDUSTRIAL** STANDARDS BULLETIN	Code:
	Subject: EXPLANATION OF DEVELOPMENT **OF** STANDARD REPAIR **TIMES (SRT)**	Date: 9/21/98 Page: 2 of 3 Document Control: Initials:

Application: All maintenance actions.

Purpose: To provide users with an explanation of how Standard Repair Times are developed and applied at NYCT.

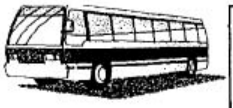
How Times are Developed

The Department of Buses will provide a controlled compendium of Industrial Standards' documents. S R T s are developed from analysis of observations and work sampling data in addition to other accepted industrial engineering methods. Task Times are also developed using input from OEM SRT documents, as well as input from industry sources, including other transit agencies and bus testing programs, and industry groups such as the American Trucking Association, the American Public Transit Association and the Truck Maintenance Council. Supervisors create a comprehensive list of all the work elements or tasks required to perform a specific repair. Independent sources are analyzed to find these same work elements and determine the time required for each. The time needed for work elements that are not included in time studies is determined by conducting our own studies or by estimation, using similar elements from existing time studies. Finally, a time is determined for the entire procedure.

Standard Repair Time

Standard Repair Time includes the actual time involved in doing productive work by all maintainers, such as: removing, disassembling, cleaning, inspecting, machining, installing and adjusting vehicle parts, components or systems. Also, fabrication, painting and structural work. In addition, the following operations are included on the calculation of the SRT:

- Report and assignment time (maximum of 10 minutes).
- Move the vehicle to and from the work area. (Immovable buses and outside storage are exempt.)
- Move toolbox and required equipment to the work area. (Specialty tools will be made available.)
- Obtain tools from toolbox; wipe and put away after use.
- Package and mark parts removed for warranty, recycling, salvage, etc.
- Operate vehicle or system to check for proper operation and functioning of the repair action.
- Clean work area at completion of shift.
- Properly dispose of used fluids, such as oil and coolant.
- Write summary and input MIDAS information of work performed at completion of repair or work shift.
- Help from another maintainer (time for one person to complete the task times two).

MTA NEW YORK CITY TRANSIT DEPARTMENT OF BUSES		
	INDUSTRIAL STANDARDS BULLETIN	Code:
	Subject: **EXPLANATION OF DEVELOPMENT OF STANDARD REPAIR TIMES (SRT)**	Date: 9/21/98 Page: 3 of 3 Document Control: Initials:

Application: All maintenance actions.

Purpose: To provide users with an explanation of how Standard Repair Times are developed and applied at NYCT.

- Accessing vehicle, system or components.
- Comfort relief breaks.
- Shift changes.
- Normal work interruptions such as: seized or hard-turning fasteners, time for extremely dirty or high mileage equipment, reasonable time to get replacement parts, time for brief assistance to other mechanics, routine maintenance of shop equipment, time to obtain consumable equipment, and technical consultation with shop supervision.

Work Not Included in a SRT

- Contractual lunch and coffee break periods.
- Locating tools and required parts to perform the repair. (Specialized tools and equipment unique to the task must be available.)
- Waiting to use special tools.
- Repairing shop equipment.
- Sorting through salvage for parts.
- Reworking parts to fit a particular model of bus or adapting a part to a different application.
- Waiting for a parts' order to be filled. Replacement parts must be available within a reasonable time, e.g., available within 5 minutes at the storeroom window.

Standard Repair Time Tracking

The MIDAS system shall be used to track and report the time spent on all tasks. The line supervisors must open a work order for the job and account for all the work performed, subtracting time for breaks or lunch. The "note" area of the MIDAS work order will be used to account for and explain why jobs are not completed within the alloted time. Each SRT has a unique code in the NYCT Vehicle Maintenance Repair System (VRMS). The numbering system used is common to all the directives and bulletins distributed in the Department of Buses.

MTA NEW YORK CITY TRANSIT
DEPARTMENT OF BUSES

	INDUSTRIAL STANDARDS BULLETIN	Code:
	Subject: **EXPLANATION OF DEVELOPMENT OF STANDARD REPAIR TIMES (SRT)**	Date: 9/21/98 Page: Signoff Page Document Control Initials:

Prepared by:

Tonia Branch
Industrial Standards, Methods & Procedures
Department of Buses

Reviewed by:

Anthony Munafo
Assistant Chief Maintenance Officer
Maintenance Support & Field Support

Reviewed by:

Dana Lowell
Assistant Chief Maintenance Officer
Research & Development

Reviewed by:

John Higgins
Assistant Chief Officer
Training

MTA NEW YORK CITY TRANSIT DEPARTMENT OF BUSES		
	INDUSTRIAL STANDARDS **BULLETIN**	I Code:
	Subject: **EXPLANATION OF DEVELOPMENT OF STANDARD REPAIR TIMES (SRT)**	Date: 9/21/98 Page: Signoff Page

Recommended for Approval by:

Barbara Thomson
Assistant Chief Maintenance Officer
Industrial Standards, Methods & Procedures
Department of Buses

Approved by:

John Walsh
(Chief Maintenance Officer
Department of Buses

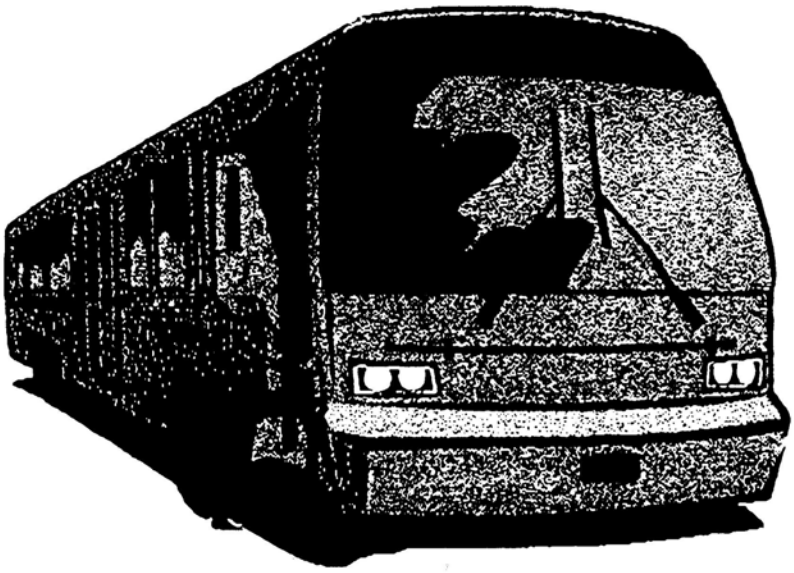
UNIVERSITY TRANSPORTATION RESEARCH CENTER

Region 2, Y-220, CCNY
NY, New York 10031

JOB STUDY REPORT

STATEN ISLAND

APRIL 21ST, 1999



Dr. Robert Paaswell
Dr. Mohsen Jafari
Ramaswamy Annamalai
Matthew Trout
Caroline Bergui

University Transportation Research Center,
Region 2, Y-220, CCNY, NY, New York 10031

Demonstration of Inspection Procedure for the MCI 6K

Date: April 21st, 1999

Location: Castleton Depot

Impartial Observers Team:

Dr. Robert Paaswell	Ramaswamy Annamalai
Matthew Trout	Caroline Bergui

Notes:

The demonstration of the inspection procedure for the MCI buses started at 7:06 am. There were three people performing the demonstration. They were Alfred Metta, Fernando Farnum, and Richard Scattone whom were helper, maintainer 1,and maintainer 2 respectively. Around 35 people (from management and union) observed the demonstration. They were asked to keep at a distance from the people performing the job and the students whom were timing the jobs. Six different buses were used for the demonstration, and were used one after another. A ten-minute coffee break was taken at 9:37 am and a 33-minute lunch break was taken at 12:08 noon. After the demonstration was over, Dr. Paaswell asked the union members and management to attend a meeting where different issues concerning the demonstration were brought out and discussed. There was a general feeling among the union members that the demonstration procedure was different from what they received. After the meeting, the impartial team was invited to Yukon Depot to note the differences between Castleton and Yukon depots.

mean and the standard deviation for the charts were determined.

University Transportation Research Center,
Region 2, Y-220, CCNY, NY, New York 10031

Site Tested Job Times

Below are the reports for the individual performances of the demonstrated tasks by the mechanics and the data in the tables are raw data.

Table 1: Maintainer 1

#	STEPS IN PROCEDUE	GENERAL TASK DESCRIPTION	BUS # 2033 (min)	BUS # 2037 (min)	BUS # 2038 (min)	BUS # 2018 (min)	BUS # 2027 (min)	BUS # 2028 (min)
1	1 – 6	Positioning the bus in work area	7	6	9	6	6	6
2	7 – 19	Interior inspection	14	10	10	11	13	15
3	20 – 21	Exterior inspection	6	11	10	14	13	13
4	22 – 39	Inspection when bus is on lift	22	24	23	22	20	21
5	40	Entering data in MIDAS	3	3	3	5	4	4
	Total Time		56	55	56	59	57	61

Table 2: Maintainer 2

#	STEPS IN PROCEDUE	GENERAL TASK DESCRIPTION	BUS # 2033 (min)	BUS # 2037 (min)	BUS # 2038 (min)	BUS # 2018 (min)	BUS # 2027 (min)	BUS # 2028 (min)
1	2 ,3, 4	Assisting Maintainer #1	3	2	2	3	4	2
2	1, 5 TO 12,	Checking fuel system	9	11	12	15	12	11
3	13	Wheel Inspection	5	6	5	5	6	6
4	14, 15, 16	Changing oil and fuel filters	26	17	16	15	22	19
5	17, 18	Fill engine with oil	3	6	5	5	5	5
	Total Time		45	42	40	43	49	43

Table 3: Helper

#	STEPS IN PROCEDUE	GENERAL TASK DESCRIPTION	BUS # 2033 (min)	BUS # 2037 (min)	BUS # 2038 (min)	BUS # 2018 (min)	BUS # 2027 (min)	BUS # 2028 (min)
1	1 – 4	Open all panels, Check antifreeze and battery, release tag axle	13	10	11	13	16	12
2	5 –7 and 12	Torque wheels, take tire pressure, and close all panels	17	18	19	17	17	18
3	8 –11	Lube bus, assist main. 1 with brake check	14	15	15	16	15	18
4	13 - 14	Fill tag axle, Drive bus off lot	10	9	10	9	9	12
Total Time			54	52	55	55	57	60

Table 4: **FINAL TIMES FOR THE INSPECTION PROCEDURE OF MCI BUSES**

#	Bus Number	Time Start	Time Finish	Total Time
1.	2033	7:06 am	8:02 am	56 minutes
2.	2037	7:58 am	8:53 am	55 minutes
3.	2038	8:54 am	10:00 am	56 minutes *
4.	2018	10:00am	10:59 am	59 minutes
5.	2027	10:59 am	11:56 am	57 minutes
6.	2028	11:56 am	1:30 pm	61 minutes *

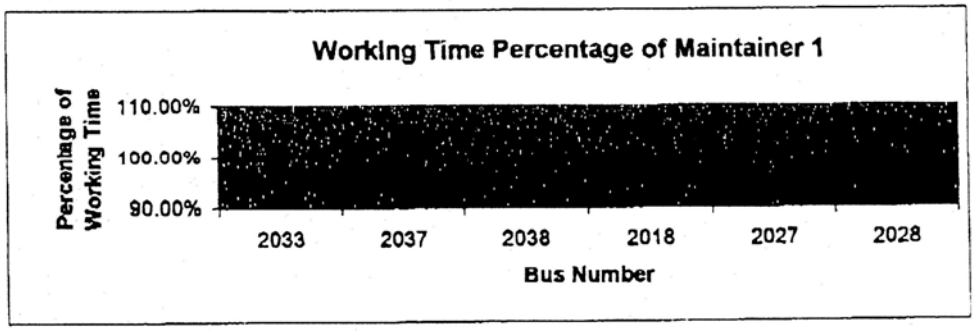
Mean: 57.33 minutes
Standard Deviation: 2.14 minutes

* -> A 10-minute coffee break was taken between 9:37 am to 9:47 am
* -> A 33-minute coffee break was taken between 12:08 am to 12:41 am

University Transportation Research Center,
Region 2, Y-220, CCNY, NY, New York 10031

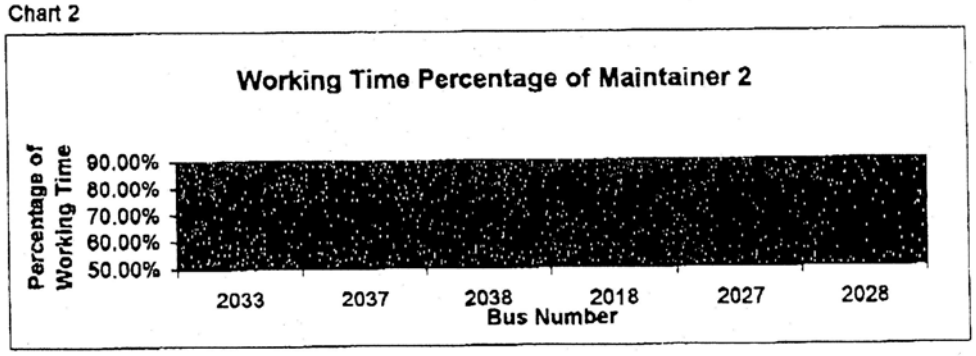
Time Study Analysis Charts

Chart 1



Mean Working Time	100%
Standard Deviation	0

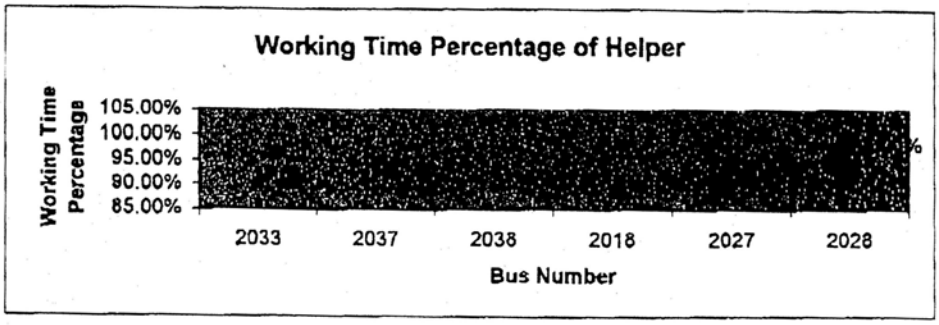
Chart 2



Mean Working Time	76%
Standard Deviation	0.055

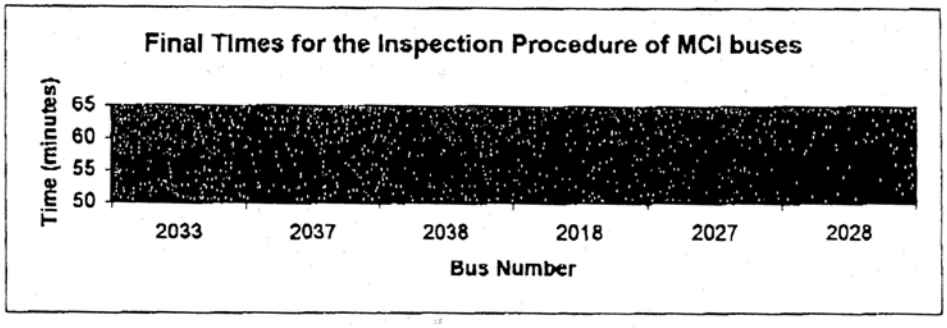
University Transportation Research Center,
Region 2, Y-220, CCNY, NY, New York 10031

Chart 3



Mean Working Time	96.50%
Standard Deviation	0.024

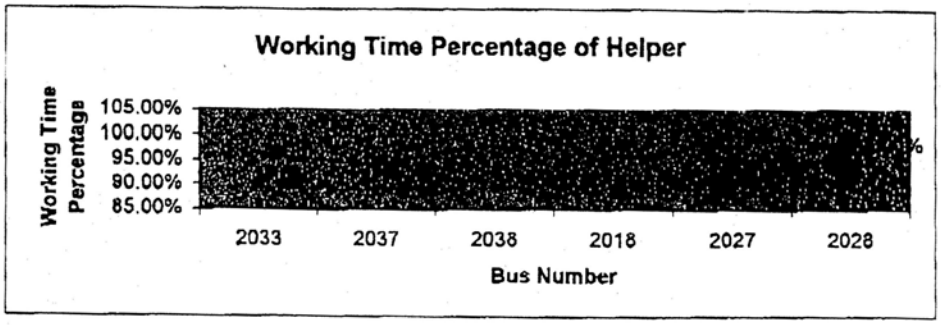
Chart 4



Mean Final Time	57.33 minutes
Standard Deviation	2.14579

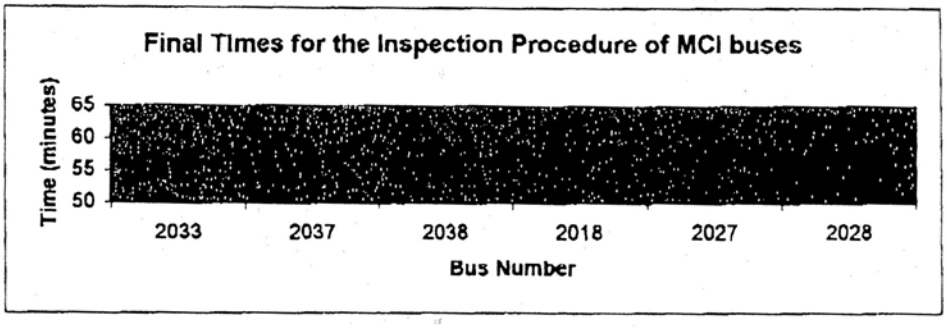
University Transportation Research Center,
Region 2, Y-220, CCNY, NY, New York 10031

Chart 3



Mean Working Time	96.50%
Standard Deviation	0.024

Chart 4



Mean Final Time	57.33 minutes
Standard Deviation	2.14579

University Transportation Research Center,
Region 2, Y-220, CCNY, NY, New York 10031

TIME STUDY ANALYSIS – April 21st, 1999

Time Taken: 57.33 minutes

Pace Rate: 1.15

Allowances:

1.Work Conditions	- 1.0%	(normal shop floor conditions, central heat, dirty and greasy)
2.Physical Requirements	- 1.0%	(based on 1-10 pounds lift for less than 25% of total time under load)
3.Mental Conditions	- 4.0%	(work requiring full attention)
4.Operators Position	- 2%	(standing)
5.Monotony	- 0%	(since cycle time is more than 30 minutes)
6.Restrictive Safety Devices	- 0.5%	(safety glasses)
7.Delay	- 1.0%	(isolated job, little coordination with adjacent jobs)
8.Movement	- 3.0%	(move once each 30 minutes on an average)

TOTAL ALLOWANCE: 12.5%

Allowance Factor = 1+ (minutes/day allowance) / (480-minutes/day allowance)

Minutes/day allowance = 480 * 12.5% = 60 minutes

Allowance Factor = 1+(60) / (480-60) = **1.14**

Standard time = Time Taken * Pace Rate * Allowance Factor
= 57.33 * 1.15 * 1.14
= 75 minutes 09 seconds

Standard time: 75 minutes

Note: The total working time in a 480-minute shift is 415 minutes. (According to contract agreement)
The total break time in a 480 minute shift is 50 minutes (10, 30, 10 minutes respectively)
There is a 5-minute wash up and 10-punchout time at the end of the day.

All the allowance values used in the above analysis has been obtained from standard tables given in the book by Donald Herzog, "Industrial Engineering Methods and Controls", Reston Publishing Company, Inc.

University Transportation Research Center,
Region 2, Y-220, CCNY, NY, New York 10031

CONCLUSION

The recommended time for the performance of the MCI 6K Inspection is 75 minutes.

This time is recommended under the following conditions only:

1. The procedure to be followed for the inspection is attached to this report.
2. The time should be stopped when any problem other than the ones written in the procedure is encountered and the foreman has to be summoned.
3. The lubing of the doors and panels are not required.
4. The clock should stop if tools become unusable.
5. This recommended time does not include a set up time.
6. The time should start only when the bus is in position in the work area.

MTA NEW YORK CITY TRANSIT
DEPARTMENT OF BUSES

TECHNICAL SERVICES
PROCESS SHEET

Subject:
PROCESS SHEET FOR PERFORMING THE MCI 6K ISPF INSPECTION

Date: 4/15/99

Page: 1 of 5

MAINTAINER #1

1. POSITION BUS IN WORK AREA (put bus on the lift).
2. PRINT ATEC/DDEC CODES
3. CHECK SPEEDOMETER OPERATION.
4. CHECK PARKING BRAKE OPERATION.
5. CHECK AND ACTIVATE KNEELING SYSTEM AND INTERLOCK. CHECK HIGH RISE SYSTEM.
6. CHECK STARTER, STARTER INTERLOCK, CONTROL PANEL AND OPERATORS SEAT BELT.
7. CHECK LIGHTING SYSTEM
   - A) EXTERIOR (MAINTAINER #2 TO ASSIST)
   - B) CHECK HORN, BACKUP ALARM
   - C) DASH LIGHTS, GAUGES, TEST MODULE & FIRE ALARM
8. CHECK & SERVICE AIR SYSTEM.
   - A). FOR LEAKS.
   - B). AIR GOVERNOR CUT IN & CUT OUT PRESSURE.
   - C). VERIFY LOW AIR PRESSURE ALARM OPERATION.
9. AIR DRYER OPERATION AND PURGE CYCLE.
10. CHECK ACCELERATOR AND BRAKE PEDALS PINS, ROLLER & HARDWARE, SHIFT TOWER OPERATION.
11. CHECK ACCESSORIES
    - A) SUN SHADES
    - B) MAP BOX
    - D) FRONT MESSAGE BOX
    - E) CHECK POWER MIRRORS
12. CHECK RADIO, P.A. AND SPEAK EASY SYSTEM.
13. CHECK TELESCOPIC WHEEL AND STEERING COLUMN TILT LOCK PLATE & MOUNTING HARDWARE.
14. CHECK FRONT DOOR INTERLOCK OPERATION (if equipped).
15. CHECK WINDSHIELD WIPER & WASHER SYSTEMS OPERATION.
16. RECORD DASH GAUGE VOLTAGE READING.
17. CHECK PASSENGER SIGNALS(#1 CURBSIDE & #1 STREETSIDE) INCLUDING STOP REQUEST SIGN
18. CHECK BODY CONDITION (INTERIOR).
    - A) CHECK ALL ROOF VENTS, DOORS and WINDOWS FOR PROPER OPERATION AND SEALING.
    - B) CHECK SEATS AND STANCHIONS FOR PROPER SECUREMENT.
    - C) CHECK SEAT FABRIC.
    - D) CHECK WHEEL CHAIR TIE DOWNS
    - E) CHECK INTERIOR LIGHTING SYSTEM
19. CHECK FIRE EXTINGUISHER FOR CHARGE & MOUNT.

    THE NEXT THREE STEPS SHOULD BE PERFORMED SIMULTANEOUSLY.
20. CHECK EXTERIOR BODY CONDITION. MARK ALL DAMMAGE ON THE BODY CHART.

MTA NEW YORK CITY TRANSIT
DEPARTMENT OF BUSES

	TECHNICAL SERVICES PROCESS SHEET	
	Subject: PROCESS SHEET FOR PERFORMING THE MCI 6K ISPF INSPECTION	Date: 4/15/99
		Page: 2 of 5

MAITAINER #1

21. CHECK MODEL OF TIRES.
22. PERFORM ELECTRICAL CHECK SHEET ITEMS (MINOR).
23. CHECK AMEREX FIRE SUPPRESSION SYSTEM.
24. CHECK FUEL TANK AND FILLER CAP.
25. CHECK STEERING SYSTEM.
    A) GEAR LINKAGE AND SHAFT.
26. CHECK FRONT SUSPENSION, STABILIZER LINKS AND BUSHINGS, RIDE HEIGHT, MOUNTING BOLTS, SHOCK ABSORBERS, BULKHEADS AND CHASSIS.
27. CHECK FRONT RADIUS ROD BUSHINGS, TIE ROD ENDS.
28. CHECK SERVICE AND PARKING BRAKE SYSTEMS FOR LEAKS. (Assist from helper for throws)
    A) LINING WEAR: RF_____LF_____RR_____LR_____
    B) THROW(CHECK WITH DASH GAUGE PRESSURE AT 90-100PSI)
       S-CAM: RF_____LF_____RR____LR____
    C) TRAILING AXLE LINING WEAR: LH_____RH_____
    D) TRAILING AXLE THROW RH LH
29. RECORD TIRES THREAD DEPTH
30. CHECK DRIVE SHAFT U-JOINTS. MAKE SURE DRIVE SHAFT GUARD IS IN PLACE.
31. INSPECT TRAILING AXLE MOUNTING BUSHINGS, LATCHING AND LOCKING MECHANISM.
32. CHECK REAR RADIUS ROD BUSHINGS, TIE ROD ENDS (INCLUDING TAG AXLE).
33. CHECK REAR SUSPENSION. STABILIZER LINKS AND BUSHINGS, RIDE HEIGHT, MOUNTING BOLTS, SHOCK ABSORBERS, BULKHEADS AND CHASSIS.
34. CHECK & SERVICE AIR SYSTEM
    A) CONDITION OF LINES, HOSES AND CLAMPS.
    B) DRAIN AIR TANKS & ACCUMULATOR.
    C) CONDITION OF TANKS.
35. CHECK KING PINS (FRONT & TAG AXLE).
36. CHECK ABS PERFORMANCE. MAKE A LIGHT BRAKE APPLICATION AND TURN MASTER SWITCH "ON" WHILE HOLDING THE BRAKE.
37. ENGINE OIL PRESSURE AT
    A) IDLE
    B) TOP RPM
38. PERFORM ENGINE RPM TEST.
    A) IDLE
    B) TOP
    C) FAST IDLE
39. CHECK TRANSMISSION FLUID LEVEL BY PRESSING UP AND DOWN BUTTONS ON THE SHIFT PAD SIMULTANEOUSLY.
35. ENTER MIDAS INFORMATION

MTA NEW YORK CITY TRANSIT DEPARTMENT OF BUSES		
	TECHNICAL SERVICES PROCESS SHEET	
	Subject: PROCESS SHEET FOR PERFORMING THE MCI 6K ISPF INSPECTION	Date: 4/15/99 Page: 3 of 5

MAINTAINER #2

1. CHECK FUEL PRESSURE.
   - A) IDLE
   - B) TOP RPM
2. SET UP THE LIFT.
3. ASSIST MAINTAINER #1 IN CHECKING THE EXTERIOR LIGHTS.
4. CHECK DESTINATION SIGNS.
5. CHECK EXHAUST SYSTEM
   - A) LEAKS
   - B) SHIELDS AND MOUNTING HARDWARE INCLUDING TURBOCHARGER.
6. POWER STEERING FLUID LEVEL AND LINES.
7. ALL BELTS FOR WEAR AND TENSION.
8. CHECK AMEREX NOZZLES IN ENGINE COMPARTMENT.
9. AIR INTAKE RESTRICTION READING.
10. CHECK INTAKE CLAMPS AND HOSES.
11. COOLING SYSTEM
    - A) PRESSURE CHECK THE SYSTEM.
    - B) FAN OPERATION AND MOUNTING CONDITION.
    - C) CHECK COOLANT RECOVERY TANK, COOLANT LEVEL AND RECOVERY PUMP OPERATION.
    - D) DRAIN FAN CLUTCH FILTER.
12. CHECK RADIATOR AND CHARGE AIR COOLER CLEANLINESS.
13. WHEELS
    - A) INSPECT AND TORQUE
    - B) CHECK AXLE FLANGE FOR LEAKS AND MISSING NUTS
14. GO TO THE STOCK ROOM AND GET THE FILTERS.
15. CHANGE ENGINE OIL AND FILTERS.
16. CHANGE FUEL FILTERS.
17. CHECK ENGINE AND TRANSMISSION MOUNTS AND HOUSING/BLOCK.
18. FILL ENGINE WITH OIL

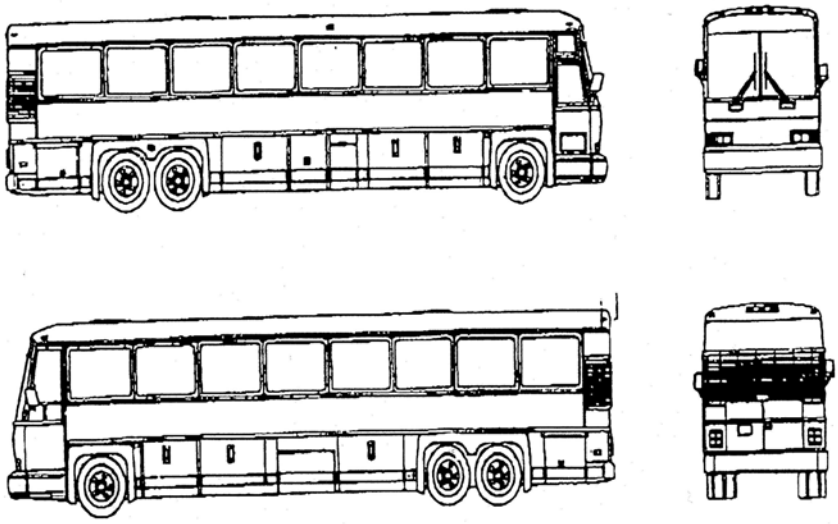
MTA NEW YORK CITY TRANSIT DEPARTMENT OF BUSES		
	TECHNICAL SERVICES PROCESS SHEET	
	Subject: PROCESS SHEET FOR PERFORMING THE MCI 6K ISPF INSPECTION	Date: 4/15/99 Page: 4 of 5

HELPER

1. OPEN ALL LUGGAGE BAYS AND ELECTRICAL PANELS.
2. RELEASE AIR FROM TAG AXLE.
3. RECORD ANTIFREEZE PROTECTION LEVEL.
4. BATTERY COMPARTMENT CHECK; CHECK CABLES, WIRING & JUNCTION BLOCKS. CHECK ROAD EMERGENCY KIT.
   HYD READINGS 1. 2.
5. ASSIST MAINTAINER #2 IN TORQUING WHEELS.
6. TAKE TIRE PRESSURES.
7. INSTALL SAFETY STANDS.
8. LUBE BUS IN ACCORDANCE WITH LUBRICATION CHART.
9. ASSITS MAINTAINER #1 BY STEPPING ON THE BRAKE IN ORDER TO RECORD THE BRAKE THROWS.
10. CHECK REAR END OIL.
11. ASSIST MAINTAINER #1 IN CHECKING THE TRAILING LOCKING AND LATCHING MECHANISM.
12. MAKE SURE ALL BAGGAGE & W/C COMPARTMENT DOORS ARE LOCKED.
13. TAG AXLE SUSPENSION MUST BE FILLED.
14. DRIVE BUS OFF THE LIFT AND PARK.

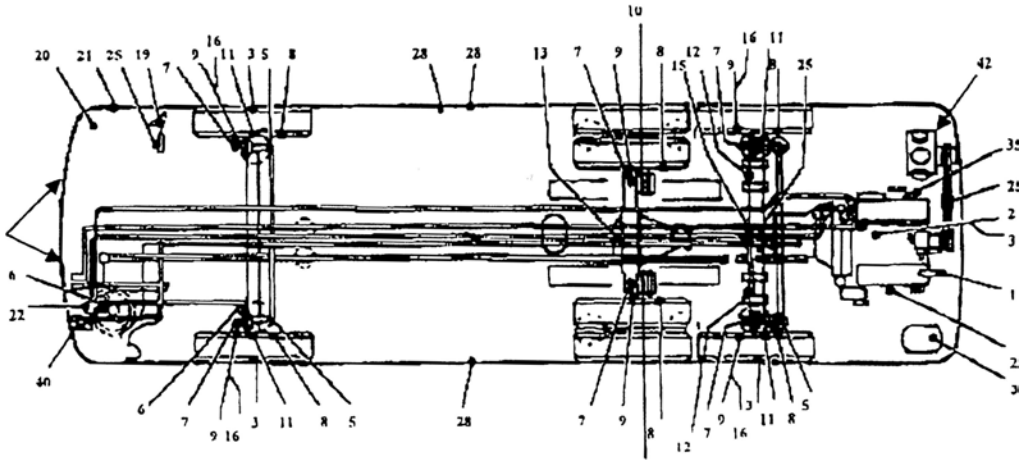
MCI BODY CHART

MARK ALL DEFECTS



MCI LUBRICATION SCHEDULE

KEYS	DESCRIPTION	LUBRICANT	METHOD	TA Part #	6K	24K
7	Slack adjusters (All)	Multi-Purpose Grease	Zerk	69-10-3400	X	
9	Brake Camshafts	Multi-Purpose Grease	Zerk	69-10-3400	X	
8	Anchor Pins (Drum Brakes)	Multi-Purpose Grease	Apply	69-10-3400	X	
14	Driveshaft Assembly	Multi-Purpose Grease	Zerk	69-10-3400	X	
11	Front & Trailing Axle Knuckle pin & Bushings	Multi-Purpose Grease	Zerk	69-10-3400	X	
5	Tie Rod Ends	Multi-Purpose Grease	Zerk	69-10-3400	X	
	All doors Locks	Multi-Purpose Grease	Apply	69-10-3400	X	
28	Baggage/Service Doors and Shafts	Multi-Purpose Grease	Apply	69-10-3400		X
21	Entrance Door Hinges and Bearings	Multi-Purpose Grease	Apply	69-10-3400	X	
20	Entrance Door Mechanism	Multi-Purpose Grease	Apply	69-10-3400	X	
19	Entrance Door Locking Claw	Multi-Purpose Grease	Apply	69-10-3400	X	
25	Air Cylinders	Motor Oil SAE 15W-40	Apply	69-12-2178		X
1	Engine Crankcase Oil	Motor Oil SAE 15W-40	Drain & Refill	69-12-2178	X	
6	Drag Link Ends	Multi-Purpose Grease	Zerk	69-10-3400	X	
22	Steering Column	Multi-Purpose Grease	Zerk	69-10-3400	X	
10	Rear Brake Chambers	Multi-Purpose Grease	Zerk	69-12-2562		X
40	Brake Application Valve Linkage (2)	Multi-Purpose Grease	Zerk	69-10-3400	X	
42	A/C Compressor mounting rod	Multi-Purpose Grease	Zerk	69-10-3400	X	
41	Front Bumper Hinges	Multi-Purpose Grease	Zerk	69-10-3400	X	
15	Trailing Axle Latching Mechanism	Multi-Purpose Grease	Apply	69-10-3400	X	



ELECTRICAL CHECK OFF and REPAIR SHEET (MINOR)
MCI BUS ONLY

BUS#_____ DEPOT_____ DATE_____

HUBODOMETER READING_____

	ITEM	CRITERIA	P	F	REMARKS
A.	CHECK ENGINE COMPARTMENT FOR LOOSE OR CORRODED CONECTIONS, WIRING HARNESS DEFECTS AND WIRES LYING ON ENGINE OR TRANSMISSION	FREE OF LOOSE OR CORRODED CONNECTIONS, WIRING HARNESS DEFECTS ANDWIRES LYING ON ENG OR TRANS			
B.	ALTERNATOR (D.C., FIELD AND RELAY TERMINAL)	MUST NOT BE LOOSE OR CORRODED			
C.	ENGINE OIL PRESSURE SWITCH (STUD & TERMINAL)	MUST NOT BE LOOSE OR CORRODED			
D.	ENGINE LOW COOLANT PROBE	MUST BE OPERABLE			
E.	BATTERY & ALTERNATOR CABLES	MUST BE CLAMPED & SUPPORTED			
F.	FUEL & OIL LINES	MUST BE SECURED			
G.	ENGINE COMPARTMENT LIGHTS	MUST BE OPERABLE			
H.	CHECK CONDITION OF WIRES IN THE BATTERY COMPARTMENT	MUST NOT BE LOOSE OR CORRODED			
I.	CHECK CONDITION OF WIRES IN THE FRONT BUMPER COMPARTMENT	MUST NOT BE LOOSE OR CORRODED			
J.	CHECK CONDITION OF WIRES IN FRONT JUNCTION BOX (LOCATED BELOW THE OPERATORS WINDOW)	MUST NOT BE LOOSE OR CORRODED			
K.	OPEN A/C, DDEC & ATEC JUNCTION BOX (LOCATED ON THE SIDE WALL OF THE #1 LH BAGGAGE COMPARTMENT) AND CHECK KNEELING CONTROL VALVES	ALL COMPONENTS MUST BE WORKING AND FREE OF FRAYS & CHAFING			
L.	OPEN THE REAR JUNCTION BOX COVER (LOCATED BEHIND LH ENGINE SERVICE DOOR)	ALL COMPONENTS MUST BE WORKING AND FREE OF FRAYS & CHAFING			
M.	CHECK 24 VOLT REGULATOR IN #3 LUGGAGE COMPARTMENT	MUST BE FREE OF FRAYS, COROSION & CHAFING			

Please record all defects In the Remarks column.

INSPECTED BY:_____

REPAIRS MADE BY:_____

LINE SUPERVISOR:_____

SUPERINTENDENT:_____

MTA - NEW YORK CITY TRANSIT
DEPARTMENT OF BUSES
AMEREX FIRE SUPPRESSION CHECK SHEET

DEPOT:_____ DATE:_____

BUS #:_____ HUBODOMETER:_____

ACTION	DEFECT	OK	REPAIR MADE
1. Check that all components are present and in their original location.			
2. Check that all manual actuators are unobstructed by clutter.			
3. Check that tamper indicators, lock wire seals and pull pins are intact.			
4. Check that the maintenance tag or certificate is in place. Record date of inspection and initials of inspector on tag. Responsibility of AMEREX.			
5. Check the physical condition of all components for damage or conditions that may prevent operation.			
6. Check the nozzles. All blow -off caps must be intact and in place. Nozzle outlets must be unobstructed and properly aimed.			
7. Check that all components, agent cylinders, control heads, actuators, hose systems, wiring and detectors are securely mounted and that all wiring connections are sealed from the weather.			
8. Check that all "In Case of Fire" instruction labels and suppression agent cylinder and nitrogen cylinder labels are intact, clean and legible.			

INSPECTED BY:_____ I/S:_____

REPAIRS MADE BY:_____ SUPT.:_____

New York City Transit
Subway Surface Supervisors Association
And
Transit Supervisors Organization

Productivity Incentive Program
Union Contract
Memorandum of Understanding

Appendix 2----------SSSA Memorandum of Understanding, Appendix B

Appendix B

Whereas, NYC Transit has entered into agreements with the unions representing the hourly workforce concerning productivity/work quality standards in the maintenance, repair and inspection of buses.

Whereas, NYC Transit and the Subway Surface Supervisors Association agree that Maintenance Supervisors have an important role in overseeing and implementing these productivity/quality standards; and

The parties agree to the following:

1. The Maintenance Supervisor shall assign each maintainer under their supervision to primary maintenance functions for 95% of the productive work time on each shift. Productive work-time includes all work hours absent contractual breaks and the scheduled lunch period. Primary maintenance functions includes duties such as: removing, disassembling, cleaning, inspecting, machining, installing and adjusting vehicle parts, components or systems, fabrication, painting and structural work.

2. Such assignments will be based upon the quality/productivity standards agreed upon by the unions representing the hourly workforce, i.e. the flat rate manual times or the times established by the Work Procedure Review Teams for certain core jobs.

3. Time lost due to the lack of parts, unavailable tools or equipment or the unavailability of buses shall not exceed 5% of productive time on any shift.

4. Maintenance Supervisors shall help to monitor the work performance of the hourly workforce and will be responsible for helping to identify, counsel and help train maintainers who fail to meet normal productivity/quality standards as agreed upon by the hourly unions with NYC Transit.

5. Daily work assignments will be made to reflect the following principle:

   > To achieve maximum productivity with a quality work product recognizing that some employees have different skill levels and fairly distributing work assignments taking into consideration those skill levels and performance.

6. Maintenance Supervisors who meet the standards outlined in the above provisions at least 90% of the time in each quarter shall receive a $600 bonus to be paid within 20 work days from the end of the quarter. After the first two (2) full quarters, a supervisor must achieve 95% compliance to receive the

Appendix 2----------SSSA Memorandum of Understanding, Appendix B

bonus. Commencing in the second quarter of the year 2002, the bonus will be increased to $700.

7. In order to receive the bonus, the supervisor must actually work forty (40) days in the quarter in which the bonus is to be paid. Paid vacation shall count as time actually worked.

8. Management and the Union will monitor the program on a daily basis. Compliance will be measured and monitored utilizing NYC Transit's work order system.

9. The intent of this program is to reward superior performance, however, no punitive or disciplinary action resulting from individual non-achievement of this incentive will be taken based upon this agreement.

10. The agreement shall be reviewed every six (6) months by management and the Union to address problems. Any changes, amendments, or modifications to this agreement, must be agreed to by both parties.

11. Within 60 days after full ratification of the contract, all Maintenance Supervisors will receive a $300 bonus payment.

Appendix 3----------TSO Memorandum of Understanding, Appendix A

APPENDIX A

Whereas, NYC Transit has entered into agreements with the unions representing the hourly workforce concerning productivity/work quality standards in the maintenance, repair and inspection of buses.

Whereas, NYC Transit and the Transit Supervisors Organization agree that Maintenance Supervisors have an important role in overseeing and implementing these productivity/quality standards; and

The parties agree to the following:

1. The Maintenance Supervisor shall assign each maintainer under their supervision to primary maintenance functions for 95% of the productive work time on each shift. Productive work-time includes all work hours absent contractual breaks and the scheduled lunch period. Primary maintenance functions include the following: removing disassembling, cleaning, inspecting, machining, installing and adjusting vehicle parts, components or systems, fabrication, painting and structural work.
2. Such assignments will be based upon the quality/productivity standards agreed upon by the unions representing the hourly workforce, i.e. the flat rate manual times or the times established by the Work Procedure Review Teams for certain core jobs.
3. Time lost due to the lack of parts, unavailable tools or equipment or the unavailability of buses shall not exceed 5% of productive time on any shift.
4. Maintenance Supervisors shall help to monitor the work performance of the hourly workforce and will be responsible for helping to identify, counsel and train

maintainers who fail to meet normal productivity/quality standards as agreed upon by the hourly unions with NYC Transit.

5. Daily work assignments will be made to reflect the following two principles:

   a) To fairly distribute work assignments among all employees to develop the overall skill level of all maintainers; and

   b) To achieve maximum productivity with a quality work product recognizing that some employees have different skill levels.

6. Maintenance Supervisors who meet the standards outlined in the above provisions at least 90% of the time in each quarter shall receive a $600 bonus to be paid within 20 work days from the end of the quarter.

   After the first two (2) full quarters, a supervisor must achieve 95% compliance to receive the bonus. Commencing in the second quarter of the year 2002, the bonus will be increased to $700.

7. In order to receive the bonus, the supervisor must actually work eight (8) weeks in the quarter in which the bonus is to be paid. Paid vacation shall count as time actually worked.

8. Management and the Union will monitor the program on a daily basis. Compliance will be measured and monitored utilizing NYC Transit's work order system.

9. The above-mentioned bonus program will commence when the hourly program commences. In addition, the maintenance supervisors will receive a one time $300 payment to be paid within 60 days of the full ratification of this agreement.

New York City Transit

Amalgamated Transit Union
And
Transport Workers Union

Productivity Incentive Program

Union Contracts

1999 Contract

In full settlement of all issues raised by the union and management, the following has been agreed to subject to the approval of the principals:

Whereas, the parties entered into an agreement in 1994 and 1996 concerning the improvement of task times for certain bus repair functions; and

Whereas, the parties are seeking to immediately improve maintenance productivity; to continue to improve productivity over future years; and to reward employees with a bonus where agreed upon levels of performance are met; and

Whereas, it is the parties; intent that the work performed meet industry standards for safety, quality, reliability, functionality and appearance, and

Whereas, the provisions in the 1994 and 1996 agreements related to the Work Procedure Review Team and reclassification shall continue in effect. It is understood that any reclassification can be appealed directly for review by the Senior Vice President, Dept. of Buses.

The parties agree to the following:

A. The "flat rate times" will become the agreed upon repair times for all maintenance functions when the program commences. Where applicable, trouble shooting and diagnostics are covered by this agreement. The parties agree to work together to commence the program as soon as possible.

B. The Union and management agree to the continuation of the Work Procedure Review Team as the accepted process for reviewing and reevaluating the agreed upon standard repair times and procedures under the following circumstances:

   1. If a job cannot be performed within the "flat rate time" more than 80% of the time, the job can be referred to the Team; and

   2. Management may refer a job for review where it consistently is performed in less than the "flat rate time". Management will waive its right to implement this provision during the term of this collective bargaining agreement; and

3. Jobs or procedures which have no prescribed "flat rate times" will be evaluated by the Team.

C. *CMF Programs*

1. The "flat rate times" will immediately be adopted as the repair time for all CMF programs.

2. The process used by the Work Procedure Review Team will be utilized to develop repair times for any jobs or procedures that do not have a prescribed "flat rate" repair time.

D. *Core Jobs*

1. Core jobs will be performed in accordance with the times which have already been established by the Work Procedure Review Team, excluding the 16 core jobs that were established without TWU participation which will be at flat rate times.

E. In January all maintainers shall receive a $300 bonus.

F. Central Road Service and Support Fleet maintainers will receive a $300 bonus in January 2000 with the understanding that the parties will work expeditiously toward reaching a productivity agreement for these groups.

G. Commencing the first two full quarters of the program, any individual maintainer who meets the above stated standards on 90% of the assigned jobs or procedures, shall receive a $600 bonus to be paid within 20 work days from the end of the quarter. After the first two full quarters, a maintainer must achieve 95% compliance to receive the bonus. Commencing in the second quarter of the year 2002, the bonus will be increased to $700.

H. The computation for compliance with the flat rate times will be a comparison of the flat rate time total for the assigned jobs compared against the total time the maintainer utilized to complete the assigned jobs.

I. In order to receive the bonus, the employee must actually work eight (8) weeks in the quarter in which the bonus is to be paid. Paid vacation shall count as time actually worked.

J. Management and the Union will monitor the program on a daily basis. Compliance will be measured and monitored utilizing NYC Transit's work order system.

K. All flat rate time assume that the bus is in position, parts are at the bus and any special tools and equipment are available. Contract meal and breaks are not including in work time.

L. It is in the interest of both parties to maintain a productivity agreement beyond the term of this agreement.

This agreement may not be entered into evidence during any interest arbitration procedures on the contract to be effective December 16, 1999.

This divisional package is subject to an entire agreement on a successor agreement for the Transport Workers Union, Local 100.

12/17/99

Millard Seay,
Senior Vice President
Department of Buses
MTA New York City Transit

Willie James,
President
TWU, Local 100

12-13-99

John Walsh,
Chief Maintenance Officer
Department of Buses
MTA, New York City Transit

James Whelan,
Director
TWU, Local 100

12/15/99

Ralph J. Agritelley,
Vice President
Office of Labor Relations
MTA, New York City Transit

12/13/99

Eddie Melendez,
Vice President
TWU, Local 100

1996 Contract

1996 Contract, Pg. 7.

Surface Maintenance Productivity Procedures

The parties will immediately implement the 26 work items currently agreed to. In addition the work review process established by the collective bargaining agreement will continue and the additional standards will be implemented each week upon completion of either agreement as to standards or as directed by the impartial expert. It is agreed that it is the intention of the parties to continue reviewing currently identified job items as expeditiously as possible but not to exceed 3 additional months. As other job items are identified the parties agree to establish work standards as soon as possible and they are not required to wait for this process to implement those times.

It is also understood that these standards may be improved upon and the parties agree to work together to continually improve maintenance productivity. This agreement shall not be construed as a waiver of any future argument that such additional productivity gains are subject to gainsharing.

The parties recognize that some incumbent maintainers may require additional training to perform at the level of productivity that is necessary. The work review team * shall be responsible for determining the additional training that is required as well as whether the additional training has sufficed to allow the mechanics to obtain the required degree of proficiency. Any maintainer who is unable to attain such proficiency due to aptitude, even with additional training, will be offered reassignment to another appropriate budgeted vacancy within the Authority, to the extent

* For these particular purposes (additional training and proficiency) there shall be an OA work review team (one representative from the union, one management, and the Impartial Expert) and a TA review team (one representative from the union, one management, and the Impartial Expert). The parties shall choose the Impartial Expert for the purposes of these additional work review team functions within one week of implementation of the surface maintenance productivity procedures.

1994 CONTRACT

1994 Contract
(pg. 12)

SECTION 1.13 - FARMING OUT OF WORK

The Authorities shall give favorable consideration to having certain repair work performed by their employees instead of being farmed out, provided the work is performed with existing facilities, without adding employees, and that the cost of such work is competitive with outside manufacturers as to the quality, price, time of performance, and will not conflict with the performance of normal maintenance.

The Authorities shall continue a joint Authority-Union Committee to facilitate communication between the parties as to work being considered for farming out, and the advisability of having such work performed by present employees. The committee may make recommendations to the Authorities concerning the farming out of work. The Committee shall include representatives of the Departments of Rapid Transit, Surface and Operations Support, and the Operating Authority and the Union. The Committee shall keep written minutes and shall meet monthly, unless no farming-out proposal is pending.

Before any work, as described above, is farmed out, the Authority shall provide the committee with copies of the information submitted to the prospective bidders on the items proposed to be farmed out, thus, enabling the Union representatives to prepare and submit a proposal for the performance of such work by the Authority's employees within the time frame afforded the prospective bidder to submit a bid. The information to the appropriate committee shall be furnished to it not later than the information is made available to the prospective bidder.

The decision with respect to the farming out of any particular work shall remain solely that of the Authority.

Sec. 1.22 Miscellaneous Provisions

H. Work Procedure Review Team

A Work Procedure Review Team shall be established in the Department of Buses to review such tasks or functions performed in the operating depots as are submitted to the Team and recommend a norm or standard for the performance of these functions in the TA/OA Maintenance Divisions. In making its recommendations the work procedure review team shall be guided by the principle that the norm or standard should be the lowest reasonable and appropriate time within which a trained mechanic could perform a task or function on an ongoing basis.

The Team shall consist of four members, two of whom shall be designated by the Union and two of whom shall be designated by the Authorities. The parties shall determine who their representatives shall be and have the option of designating non TA/OA employees or non Union officials.

The Team shall review the present work performance of any function submitted to it in recommending a norm for that function, as well as possible variants in the different work sites. The recommendation of a majority of the Team shall be the norm for the task or function.

This Team shall function so long as both parties agree thereto.

Where at least the majority of the Team is unable to make a recommendation, the Chief Maintenance Officer and/or the appropriate TWU Vice President will propose a norm taking into consideration the findings of the Team. If no

agreement is reached, the parties shall submit the dispute to for final and binding resolution. It is understood that any disputes will be resolved expeditiously.

Work time savings, if any, over present performance, shall not be used to reduce present manning levels or overtime work but rather to enhance the operating efficiency of the fleet.

Failure to meet a norm shall not be the basis for discipline in and of itself.

APPENDIX D

Houston Metro—Additional Information on Painting

INCREASE PRODUCTIVITY
IN THE BODY SHOP

Time Standards

We are looking at time standards for paint prep and bus painting. [See work orders for time standards.] The work times on the cards are based on the actual time it takes an average body person to perform the work. All times on the work orders are achievable if a person will apply themselves.

The team approach to working on a bus will be curtailed. A body person will be assigned an area of the bus to work on with the standard time it takes to complete the assignment.

ASSEMBLY WORK—STREET SIDE

The following items are to be installed (new or reconditioned)

1. Access door handles	1.5	Hrs.
2. Lights	2	Hrs.
3. Rub railing under windows	1	Hr.
4. Wheel rubber molding and molding support	1.5	Hrs.
5. Total hours needed to complete these tasks	6	Hrs.
6. Bus # _____ Date: _____ Emp# _____ Actual		Hrs.

ASSEMBLY WORK—REAR

The following items are to be installed (new or reconditioned)

1. Lights	3	Hrs.
2. Railroad decal and license plate	1	Hr.
3. Door handles	1	Hr.
4. Total hours needed to complete these tasks	5	Hrs.
5. Bus # _____ Date: _____ Emp# _____ Actual		Hrs.

ASSEMBLY WORK—FRONT

The following items are to be installed (new or reconditioned)

1. Two (2) mirrors	1	Hr.
2. Two (2) wipers	1	Hr.
3. Access door handle	0.5	Hr.
4. License plate	0.5	Hr.
5. Signal lights	1	Hr.
6. Total hours needed to complete these tasks	4	Hrs.
7. Bus # _____ Date: _____ Emp# _____ Actual		Hrs.

COMPLETE PAINT

The following items are applicable to a complete paint

1. Foreman inspection of bus prior to painting—initial_____		Hrs.
2. Cleaning and masking–painting black-blue-red	96	Hrs.
3. Masking and painting white and clear	24	Hrs.
4. Removal of tape residue, any overspray prior to installing parts	8	Hrs.
5. Total hours needed to complete these tasks	128	Hrs.
6. Bus # _____ Date: _____ Emp# _____ Actual		Hrs.

SANDING AND PREP WORK—REAR

The following items are to be removed before sanding

1. Door handles (A/C and engine door)	1.5	Hrs.
2. Lights (A/C and engine door)	1.5	Hrs
3. All decals	2.5	Hrs.
4. License plate	0.5	Hr.
5. Sanding	8	Hrs.
6. Total hours needed to complete these tasks	14	Hrs.
7. Bus # _____ Date: _____ Emp# _____ Actual		Hrs.

SANDING AND PREP WORK—ROOF

The following items are to be removed before sanding

1. Sanding	10	Hrs.
2. Total hours needed to complete these tasks	10	Hrs.
3. Bus # _____ Date: _____ Emp# _____ Actual		Hrs.

SANDING AND PREP WORK—STREET SIDE

The following items are to be removed before sanding

1. All access door handles	3.5	Hrs.
2. All lights	2.5	Hrs.
3. Rub railing under windows (inspect)	1	Hr.
4. Rub railing under side panel (inspect)	1	Hr.
5. Wheel molding and molding support	1.5	Hrs.
6. All decals	1.5	Hrs.
7. Sanding	16	Hrs.
8. Total hours needed to complete these tasks	27	Hrs.
9. Bus # _____ Date: _____ Emp# _____ Actual		Hrs.

SANDING AND PREP WORK—CURB SIDE

The following items are to be removed before sanding

1. All access door handles	2.5	Hrs.
2. All lights	3	Hrs.
3. Decals	1.5	Hrs.
4. Wheel molding and molding support	1.5	Hrs.
5. Rub railing under windows (inspect)	1	Hr.
6. Rub railing on side panels (inspect)	1	Hr.
7. Sanding	24	Hrs.
8. Total hours needed to complete these tasks	34.5	Hrs.
9. Bus # _____ Date: _____ Emp# _____ Actual		Hrs.

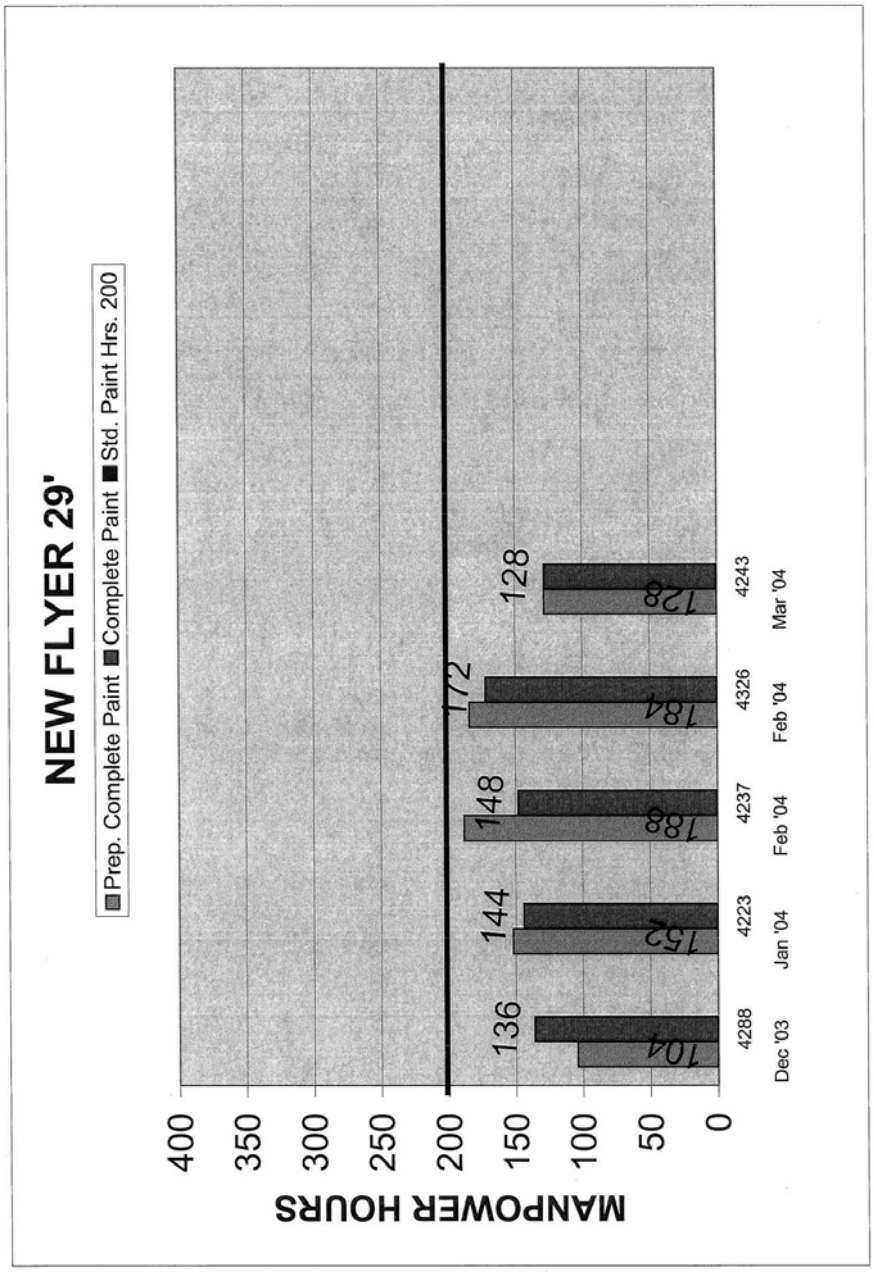
SANDING AND PREP WORK—FRONT

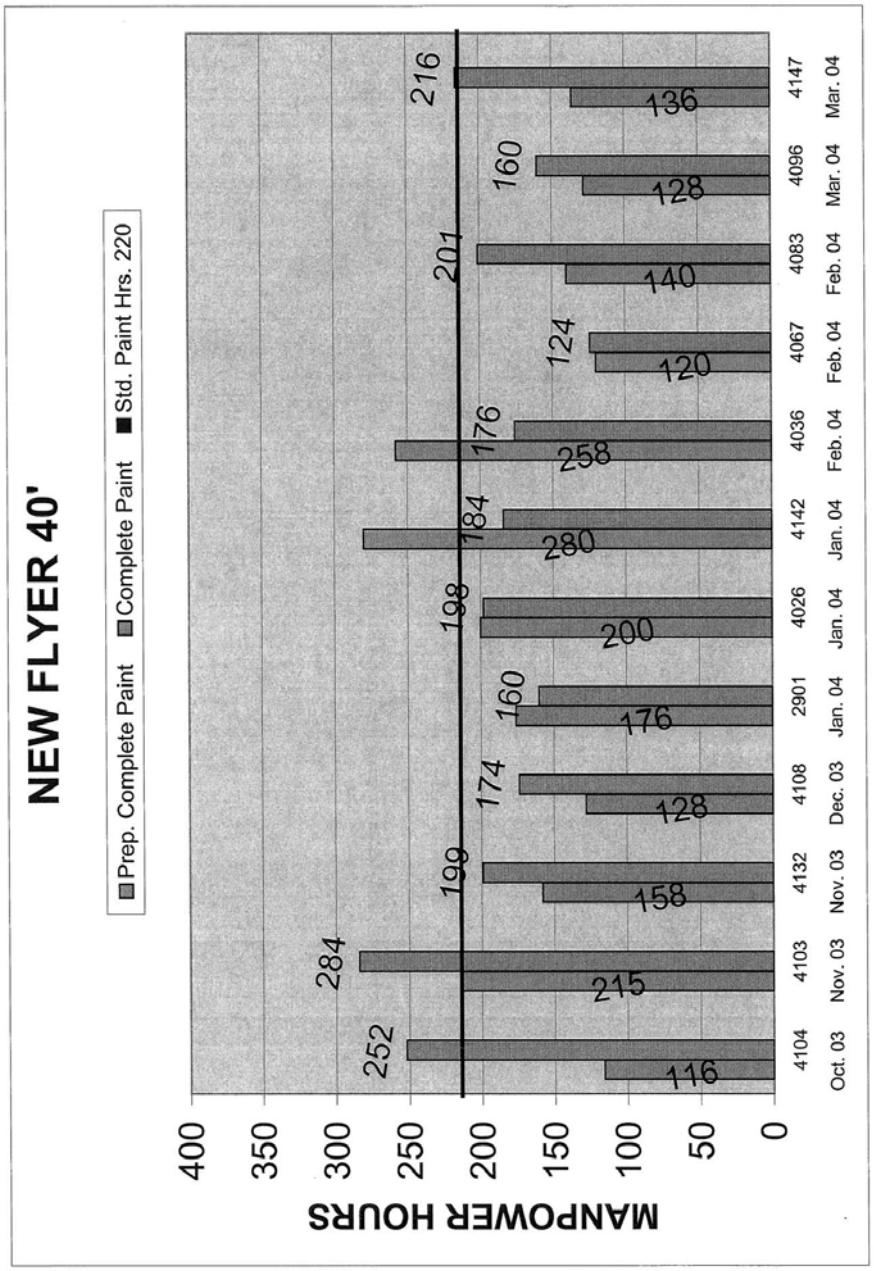
The following items are to be removed before sanding

1. Mirrors	1	Hr.
2. Wipers	1	Hr.
3. Access door handle	0.5	Hr.
4. Decals and license plate	1.5	Hrs.
5. Sanding	8	Hrs.
6. Total hours needed to complete these tasks	12	Hrs.
7. Bus # _____ Date: _____ Emp# _____ Actual		Hrs.

IKAROS 40’ TRANSIT BUS COMPLETE PAINT

The total number of hours for this entire process is: 246 hours. This is not inclusive of any accident damage or corrosion control that may need to be performed, but is inclusive of all necessary parts (mirrors, wipers, handles, etc.) that need to be sanded and painted to restore parts before installation.


NEW FLYER 29'
Prep. Complete Paint
Complete Paint
Std. Paint Hrs. 200
MANPOWER HOURS
400
350
300
250
200
150
100
50
0
136
104
144
152
148
188
172
184
128
128
4288
4223
4237
4326
4243
Dec '03
Jan '04
Feb '04
Feb '04
Mar '04


NEW FLYER 40'
Prep. Complete Paint
Complete Paint
Std. Paint Hrs. 220
MANPOWER HOURS
400
350
300
250
200
150
100
50
0
4104
4103
4132
4108
2901
4026
4142
4036
4067
4083
4096
4147
Oct. 03
Nov. 03
Nov. 03
Dec. 03
Jan. 04
Jan. 04
Jan. 04
Feb. 04
Feb. 04
Feb. 04
Mar. 04
Mar. 04
252
284
199
174
160
198
184
176
124
201
160
216
116
215
158
128
176
200
280
258
120
140
128
136

ASSEMBLY WORK—REAR

The following items are to be installed (new or reconditioned)

1. Door handles	1	Hr.
2. Marker lights (5)–Decel lights (2)–Stop-turn-backup	4	Hrs.
3. License plate and light-all reflectors	2	Hrs.
4. Total hours needed to complete these tasks	7	Hrs.
5. Bus # _____ Date: _____ Emp# _____ Actual		Hrs.

ASSEMBLY WORK—SIDE STREET

The following items are to be installed (new or reconditioned)

1. Signal lights (2)	1	Hr.
2. Marker lights (5)	1.5	Hrs.
3. Reflectors (3)	1.5	Hrs.
4. Wheel molding	1	Hr.
5. Total hours needed to complete these tasks	5	Hrs.
6. Bus # _____ Date: _____ Emp# _____ Actual		Hrs.

ASSEMBLY WORK—CURB SIDE

The following items are to be installed (new or reconditioned)

1. Marker lights (3)–Side signal (2)–Step lights	4.5	Hrs.
2. Reflectors—W/C lift signal light	1	Hr.
3. Kneeling light	0.5	Hr.
4. Wheel molding	1	Hr.
5. Total hours needed to complete these tasks	7	Hrs.
6. Bus # _____ Date: _____ Emp# _____ Actual		Hrs.

ASSEMBLY WORK—FRONT

The following items are to be installed (new or reconditioned)

1. Mirrors (2)	1	Hr.
2. Wipers (2)	1	Hr.
3. Headlight bezels	1	Hr.
4. License plate–Reflectors	1	Hr.
5. Signal lights (2)–Marker lights (5)–Step light	3	Hrs.
6. Total hours needed to complete these tasks	7	Hrs.
7. Bus # _____ Date: _____ Emp# _____ Actual		Hrs.

COMPLETE PAINT

The following items are to be installed (new or reconditioned)

1. Foreman inspection of bus prior to painting—initial_____		Hrs.
2. Cleaning and masking—painting black-blue-red	96	Hrs.
3. Masking and painting white and clear	24	Hrs.
4. Removal of tape residue, any overspray prior to installing parts	8	Hrs.
5. Total hours needed to complete these tasks	128	Hrs.
6. Bus # _____ Date: _____ Emp# _____ Actual		Hrs.

SANDING AND PREP WORK—REAR

The following items are to be removed before sanding

1. Door handles (A/C and engine door)	1	Hr.
2. Marker lights (5)–Decel lights (2)–Stop-turn-backup (6)	2	Hrs.
3. Decals and numbers	1	Hr.
4. License plate—License plate light and reflectors	1	Hr.
5. Sanding	8	Hrs.
6. Total hours needed to complete these tasks	13	Hrs.
7. Bus # _____ Date: _____ Emp# _____ Actual		Hrs.

SANDING AND PREP WORK—ROOF

The following items are to be removed before sanding

1. Sanding	10	Hrs.
2. Total hours needed to complete these tasks	10	Hrs.
3. Bus # _____ Date: _____ Emp# _____ Actual		Hrs.

SANDING AND PREP WORK—STREET SIDE

The following items are to be removed before sanding

1. Marker lights (3)	1	Hr.
2. Side signal lights (2)	1	Hr.
3. Reflectors (3)	0.5	Hr.
4. Wheel moldings	1	Hr.
5. Decals and numbers	2	Hrs.
6. Sanding	16	Hrs.
7. Total hours needed to complete these tasks	21.5	Hrs.
8. Bus # _____ Date: _____ Emp# _____ Actual		Hrs.

STANDING AND PREP WORK—CURB SIDE

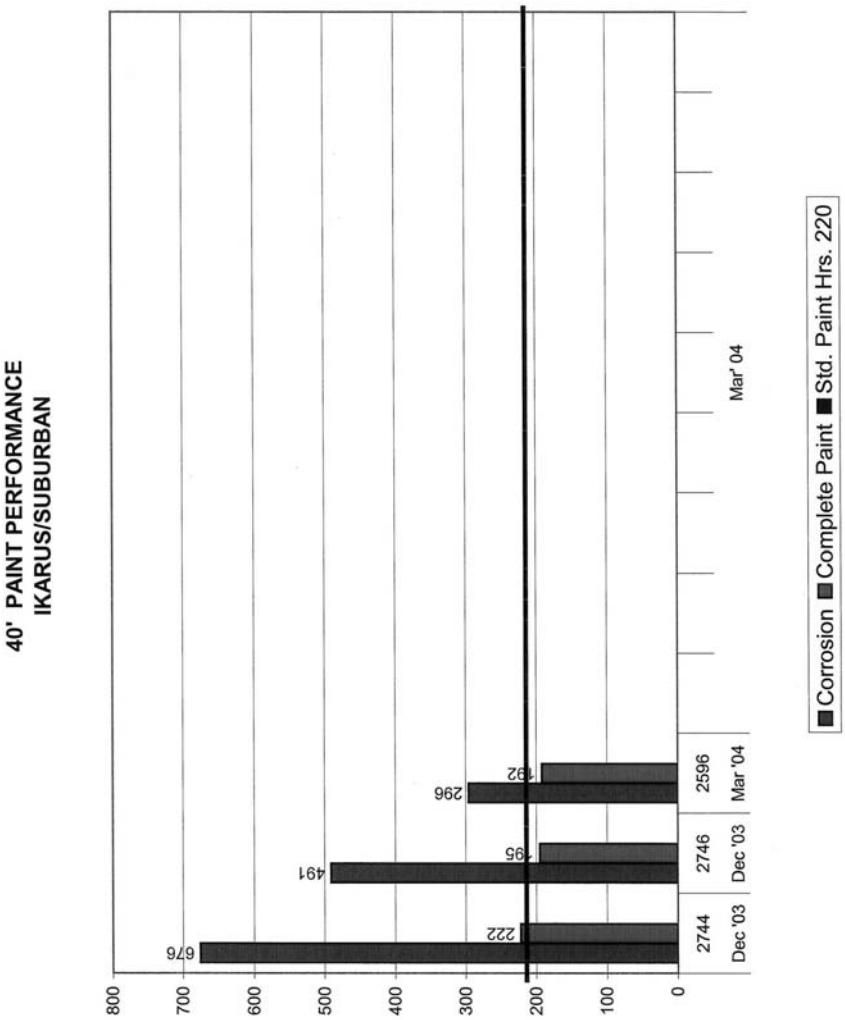
The following items are to be removed before sanding

1. Marker lights (3)	1	Hr.
2. Side signal lights (2)	1	Hr.
3. Step lights (3)	1	Hr.
4. Reflectors (3)—W/C lift signal light	1	Hr.
5. Wheel moldings	1	Hr.
6. Decals and numbers	2	Hrs.
7. Sanding	24	Hrs.
8. Total hours needed to complete these tasks	31	Hrs.
9. Bus # _____ Date: _____ Emp# _____ Actual		Hrs.

SANDING AND PREP WORK—FRONT

The following items are to be removed before sanding

1. Mirrors	1	Hr.
2. Wipers (2)–Headlight bezels (2)	2	Hrs.
3. Signal lights (2)–Marker lights (5)–Step lamp (1)–Reflectors (2)	2.5	Hrs.
4. Decals and license plate	1.5	Hrs.
5. Sanding	8	Hrs.
6. Total hours needed to complete these tasks	15	Hrs.
7. Bus # _____ Date: _____ Emp# _____ Actual		Hrs.



NEW FLYER 40' TRANSIT BUS COMPLETE PAINT

The total number of hours for this entire process is: 244.5 hours. This is not inclusive of any accident damage or corrosion control that may need to be performed, but is inclusive of all necessary parts (mirrors, wipers, handles, etc.) that need to be sanded and painted to restore parts before installation.

APPENDIX E

Orange County Transportation Authority—Additional Information on Union Agreement

LETTER OF AGREEMENT
National Institute for Automotive Service Excellence (ASE)
Certification Guidelines

(Modification of April 13, 1999 Agreement)

The Orange County Transportation Authority and Teamsters Local 952 hereby agree that the following guidelines shall apply for ASE Technician Certifications.

- There will be a twenty cents ($.20) per hour pay increase at the successful completion and passing of each of the eight (8) ASE classes.
- Upon successfully passing the L-1 or the L-2 test, an employee may receive an additional forty cents ($.40) per hour.
- The above represents a total of two dollars ($2.00) that an employee could receive per hour upon successful completion of all of the eight (8) classes and the passing of either the L-1 or the L-2 test.
- Certification pay shall begin the first pay period following the time the certificate is turned in.
- Each certificate is good for five (5) years and tests are given during May and November of each year. It is the responsibility of each employee to maintain their own certification.
- The certification pay does not increase with any base hourly wage adjustment but remains at ($.20) per certification for the life of the contract.
- Certification pay will be paid on all hours worked, PPH, vacation and sick hours.
- Certification pay will be paid at time and one-half for any overtime hour(s) worked.

Carol Alexander, OCTA

Patrick Kelly, Teamsters Local 952

3-26-02
Date

3-26-02
Date

LETTER OF AGREEMENT
GROUP INCENTIVES

(Modification of Prior Agreements)

1. **HOLD LIST – 90% or Less**

   If the Maintenance Department's Hold List for the year is 90% or less, the group bonus of $28.75 is awarded to all covered employees.

   For every 2% under 90%, an additional award of $17.25 will be awarded to all covered employees.

2. **ROADCALL MILEAGE - 9,000**

   If the Maintenance Department's Roadcall mileage is 9,000 miles between Roadcalls (end of year), $28.75 will be awarded to all covered employees.

   For every 300 miles over 9,000, an additional $11.50 will be awarded to all covered employees (ACCESS is not included.)

3. **COST PER MILE - $.44**

   If the Maintenance Department's Cost-Per-Mile is $.44 or less, $28.75 will be awarded to all covered employees.

   For every $.02 under $.44, an additional $11.50 will be awarded to all covered employees.

4. **WARRANTY RECOVERY**

   Warranty Recovery will be based on the following formula:

   - Recovery must equal $250.00 per vehicle in the OCTA active fleet.

   $28.75 basic award for all covered employees plus 20% of the total amount over $250.00 per vehicle.

5. **SPARES ON HOLD**

   Spares on hold for parts does not exceed 5% of the number of spares.

   $28.75 basic award for all covered employees for not exceeding the 5% figure.

Carol Alexander, OCTA

2-15-02
Date

Patrick Kelly, Teamsters Local 952

2-15-02
Date

Abbreviations used without definition in TRB Publications:

AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research and Development Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
SAE	Society of Automotive Engineers
TCRP	Transit Cooperative Research Program
TRB	Transportation Research Board
U.S.DOT	United States Department of Transportation