# Transit Bus Maintenance in New York State: Issues and Analysis

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ABSTRACT

Under provisions of a cooperative agreement with the Urban Mass Transportation Administration (UMTA), the New York State Legislative Commission on Critical Transportation Choices conducted a study of transit bus maintenance in the state. Twenty site visits were made and questionnaires were completed and returned by 57 percent of the bus operators. Findings were made relative to spare ratios, mixed fleets, negotiated bidding, maintenance facilities, outdoor storage of vehicles, new mechanic and continuous mechanic training programs, performance measures, management, job aids, driver involvement in maintenance programs, preventive maintenance, record keeping, computer usage, diagnostic techniques, contract management, and parts procurement and inventories. Commission staff developed a series of 27 specific recommendations to (a) improve the effectiveness of bus maintenance practices and (b) preserve the large investment of funds by federal, state, and local governments in buses and bus maintenance facilities. These recommendations are currently under review by UMTA and the final report should be available in published form in the near future.

Inadequate maintenance of transit buses is a matter of grave concern for the federal and state governments because it is these governmental units that contributed a majority of the funding for the purchase of these vehicles. Concern about the adequacy of current bus maintenance programs prompted the Urban Mass Transportation Administration (UMTA) and the New York State Legislative Commission on Critical Transportation Choices to conduct a cooperative study in the state with the largest total number of buses, a significant diversity in types of systems, and the single largest bus system in the country--the New York City Transit Authority (the Authority).

## METHODOLOGY

The study's methodology had three major components: a literature search and review, site visits to selected transit systems, and a questionnaire mailed to New York State's transit operators.

Twenty site visits were conducted to view maintenance facilities and to hold in-depth discussions with transit managers and maintenance personnel. Public, private, and "hybrid" (public-private elements) systems of varying sizes were visited. In selecting operators to be visited, a decision was made to include properties in most geographical areas of the state because conditions and problems vary significantly from area to area.

Fifty-four of the 95 (57 percent) bus organizations returned completed questionnaires containing information on

- The fleet,
- Facility age and condition,
- Work force,
- Work shifts,
- Maintenance program,
- Bus replacement,
- Level of computerization,
- Parts procurement policy,
- Maintenance performance measures utilized, and
- Percentage of operating costs devoted to maintenance.

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## FACTORS AFFECTING BUS MAINTENANCE

The key factors affecting the quality of a transit bus maintenance program are the fleet, maintenance facility, work force, and maintenance practices.

### The Fleet

The characteristics of a transit system's fleet have an effect on the ability of the organization to carry out an effective maintenance program. A basic consideration is the number of buses an operator has over and above the number needed to meet peak service needs (commonly referred to as the spare ratio). The age of the fleet also affects maintenance needs with older fleets generally requiring more maintenance. Fleet mix (the number of types and manufacturers of buses that a system has), the quality of the equipment, and the degree to which an operator files manufacturer warranty claims on defective equipment and parts also have an impact on the maintenance costs of the fleet.

### Spare Ratio

Spare ratios reported by survey respondents ranged from 0 percent to 60 percent. The larger operators had more consistent spare ratios than the smaller operators. The mean spare ratio for respondent operators with more than 100 buses ranged from 0.0 percent to 26.0 percent, with an average ratio of 13.4 percent.

An adequate spare ratio is essential for the es-

tablishment of a sound preventive maintenance program (PM). Buses must be available to be worked on when mechanics are available. Although some preventive maintenance can be completed during off-peak hours, more time is required for maintenance work than is available between morning and evening peak service demands.

Another option, performing PMs at night, was investigated during site visits. Operators lacking a night shift indicated that considerable expense would be involved in starting one. A night shift would require management to schedule additional supervisory personnel to have a supervisor on duty at all times. Additional overhead would also be required to run the garage during night hours. Finally, a large number of buses stored inside would have to be shifted around to position them for maintenance work--creating a need for additional personnel to be on duty.

Analysis of survey data did not reveal that reported spare ratios were affected by differences in management structure, average annual snowfall, population density, or size of fleet. Because on-site interviewees suggested that some smaller operators tended to have difficulties meeting their scheduled service as a result of an apparent inadequate spare ratio, the survey responses were closely examined in relation to spare ratios.

Twenty-three out of the 27 small operators reported a spare-ratio figure ranging from 0 percent to 60 percent, with 11 operators indicating a figure of 15 percent or lower. A low spare ratio requirement applied to operators with fleets of all sizes would make it impossible for certain operators to adhere to a routine PM schedule, ultimately resulting in a shortened vehicle life.

### Age of Fleet

Questionnaire results indicated that a correlation may exist between the spare bus ratio and two other variables--the age of the last bus replaced and the average fleet age. Operators with smaller fleets (25 buses or fewer) tended to replace buses more often than did their larger counterparts (fleet sizes of 101 to 200 and over 200), which had a mean last-replaced-bus age of 18 years. In comparison, the mean age of the last bus replaced for medium-sized operators (25 to 100 vehicles) was 15 years, and for small operators (25 buses or fewer), the mean age was 10 years. Furthermore, the larger operators had a higher mean fleet age than did medium- or small-sized operators. The mean fleet ages by size are as follows: over 200 buses, 9.0 years old; 101 to 200 buses, 10.3 years old; 26 to 100 buses, 7.2 years old; and 0 to 25 buses, 5.0 years old.

Private operators responding to the survey had a higher mean age for their bus fleet than public or "hybrid" operators. The mean fleet age for private companies was 8.1 years; for public operators, 6.2 years; and for hybrid operators, 5.0 years. The variance in average fleet age based on company ownership and management may be accounted for by the fact that, in many cases, privately owned and operated companies have not received federal or state funds for bus replacement, and, consequently, have elected to run their buses longer as a capital cost-saving measure.

### Fleet Mix

A considerable body of literature on transit bus maintenance and many maintenance personnel who were visited agree that a mixed fleet hinders effective maintenance by placing added pressure on labor, inventory, inspection schedules, and record keeping. For each additional bus model, mechanics must be given specialized training, new parts ordered and stocked, operating schedules disrupted for different mileage inspection intervals, and separate books kept to monitor performance for each type of bus.

In order to avoid having a mixed fleet, several managers indicated that they would prefer to purchase buses from one manufacturer on a continuing basis when they had found a bus model meeting their needs. A fleet comprised of vehicles purchased from one manufacturer would reduce inventory needs, facilitate parts procurement, lessen the amount of mechanic training required, standardize inspection intervals, and enable the transit operator to establish an ongoing relationship with the manufacturer.

It was indicated during site visits that a deterrent to the continuing purchase of buses from one specified company has been the low bid requirement for capital purchases financed in part with federal funds. Implementation of negotiated bidding by UMTA was hailed as a positive step by transit managers participating in the study.

### Quality Assurance

A factor contributing to the type and degree of complexity of the maintenance program is the original quality of the equipment. The Capital District Transportation Authority (CDTA), based in Albany, New York, has been cited by UMTA for a quality assurance program the authority implemented in connection with its recent purchase of 115 buses from Bus Industries of America (Orion), and which contains the following elements:

- On-site quality assurance reviews of welding equipment and processes,
- Stress testing of prototype equipment under actual field conditions to identify stress concentration points and to check design assumptions, and
- Destructive test analysis of main suspension assembly.

The buses subject to this quality assurance process have been in service for many months and show no evidence of structural damage; the CDTA is pleased with the program and plans to continue it when bus purchases are made in the future.

## MAINTENANCE FACILITY

The adequacy of the maintenance facility is a primary factor determining whether the property will have the ability to carry out an effective preventive maintenance program. A poor facility can result in a greater number of bus breakdowns and concomitant safety problems for transit riders, lowered employee morale leading to a poorer work product, and ultimately, a shorter lifespan for the vehicles housed and serviced there. A properly designed facility does not ensure that the maintenance program will be an excellent one, but an inadequate facility makes the achievement of an effective PM program more costly and difficult. The most common problems with facilities visited by the project team were buildings not originally constructed for bus maintenance, deficiencies in garage design, and a facility too small to accommodate the increase in the number of buses in recent years.

A salient example of a garage designed for another purpose is that of the New York City Transit Authority's 132nd Street garage in Manhattan. The three-

story building was erected in 1918 for double-decker buses that were shorter and narrower than current buses, thereby resulting in inadequate space for maneuvering and servicing modern transit vehicles. The problems of the facility are compounded by thick columns, located throughout the facility to support the upper stories, which cause difficulties in maneuvering buses through the garage and make it necessary to back up buses to service or park them. This problem is costly because extra personnel and time are required and a safety hazard caused by excessive backing up of the buses is created. In addition, the building lacks adequate drainage; bus maintainers and mechanics have difficult working conditions because they have to stand in water, oil, and grease to do their work, a situation that is causing safety problems.

Vehicle maintenance facilities initially constructed for other purposes exist throughout New York State. One upstate operator overhauls engines in a converted trolley barn, several garages are former factories, and one large operator is currently housed in a former United States Post Office building. Each of these facilities creates unique problems for the operators involved.

Many examples of inadequate garage design were discovered in the course of the study. Common problems were an insufficient number of service lanes and inadequate storage space for buses or parts. In addition, many older facilities were not designed for straight drive-through or for a minimum of right turns. A design allowing buses to be driven straight through the maintenance facility, with a minimum of backing up and right turns (which create a blind spot for the driver), is recognized as an efficient design and is incorporated into new facilities.

### Bus Storage

Twenty surveyed bus operators reported that none of their buses is stored indoors. Outdoor bus storage in cold weather contributes to difficulty in starting buses and freezing of bus subsystems. Relative to the first problem, engines of buses stored outdoors during cold weather are difficult to start in the morning unless the engines are run all night, started every 2 or 3 hr, or attached to heater units. Outdoor storage in cold weather may also result in the freezing up of buses' air suspension system and brakes, thereby increasing maintenance needs and creating potential safety hazards for passengers.

The severity of the outdoor parking problem is illustrated by the Metropolitan Suburban Bus Authority, which stores its entire fleet outside on an unpaved lot. The tires of the buses become frozen into ice and slush during winter storms. Buses that are washed and stored outdoors in freezing temperatures, at this property and at others around the state, create a different type of undesirable situation: the water dripping off the buses freezes into ice puddles. Maneuvering buses on ice increases the potential for accidents.

Vandalism, in the form of physical damage to the bus or the writing of graffiti on the bus, is exacerbated by outdoor storage. Although few operators in the state have to contend with this problem, those who do have to contend with it find that vandalism is difficult to prevent.

### Facility Sharing

Eleven transit systems in New York State, ranging in fleet size from 1 to 26 vehicles, share municipal garage facilities with a municipality. Provided adequate equipment and space for transit bus maintenance are available, this arrangement can have positive value.

## THE WORK FORCE

The effectiveness of employees involved with the maintenance program--mechanics, bus cleaners, and shifters--is a major factor determining the ability of the transit system to adequately maintain its vehicles. Many variables influence the ability of these individuals to do their jobs, including the availability of training programs, attitude of management toward the maintenance function, adequate job descriptions, availability of job aids (including maintenance manuals), design of the workplace, and the driver's role in the maintenance program.

### Training

Analysis of survey results revealed a significant difference in the mean percentage of operating costs devoted to maintenance for operators with a new mechanic training program and those operators without a training program. The mean percentage of operating costs devoted to maintenance for the former operators was 17 percent compared to 22 percent for the other operators. Furthermore, the mean percentage of operating costs devoted to maintenance was 18 percent for operators with a continuous training program and 25 percent for operators lacking such programs. Larger operators (101+) in New York are more apt to have training programs than are smaller systems (1 to 100). This greater commitment to mechanic training may be one reason that larger operators were found to operate an older fleet and to replace their last bus at an older age in comparison with smaller systems (1 to 100).

Despite the consensus within the industry on the positive effect that mechanic training has on maintenance programs, a large number of bus operators in New York lack training programs. Only 31 percent of the questionnaire respondents reported having a training program for new maintenance employees. Continuous training must be provided to upgrade maintenance skills and to orient mechanics to new equipment and state-of-the-art procedures. Although 61 percent of the responding operators had a continuous training program for experienced mechanics, 20 respondents did not.

Larger transit operators are better able to take advantage of training classes offered by bus and component manufacturers, in part because manufacturers may be unable to provide these sessions for systems with a small number of mechanics. Furthermore, smaller operators are not apt to have the time and extra personnel available to attend manufacturer-offered training sessions without shortchanging current maintenance operations. One solution to this problem may be the coordination of training programs on a regional basis.

### Management

The success of the maintenance program depends in large measure on the support of top management in terms of setting clear and concise objectives for the maintenance department. Many suggestions have been advanced to improve the effectiveness of the work force. By assessing the exact nature of task requirements--such as cleaning and servicing, inspection schedules, and major repairs--maintenance

managers can determine with precision the number and types of needed maintenance personnel.

### Job Aids

Maintenance literature emphasizes the need for written job descriptions to enhance work expectations and employee accountability by helping employees to better understand their responsibilities and management to have more control over the maintenance process. Task descriptions and time standards are other methods used by management to increase human resource productivity. Several transit managers who were visited claimed that strictly applied time standards are detrimental to effective maintenance because mechanics concerned about completing a job in a specified amount of time may be less thorough, or may not be able to take the time to make other adjustments or repairs found to be necessary.

Properly designed manufacturer's maintenance manuals can enhance the efficiency and effectiveness of bus repair. One transit manager reported that she would like to see "better, more graphic repair manuals provided by the manufacturer for quick reference for troubleshooting." London Regional Transport, for example, has translated manufacturers' manuals into easy-to-read English to help mechanics understand manufacturers' maintenance recommendations.

Another factor often overlooked when evaluating the ability of maintenance personnel to do an effective job is the work environment. Several interviewed transit managers mentioned that minor modifications in building design, such as providing adequate work space and an employee lounge, can create a more positive work environment and, as a result, a better work product. One recommendation on facility design made by transit managers to improve maintenance effectiveness is to have common lounge facilities for drivers and mechanics. A shared lounge would facilitate informal exchange between drivers and mechanics on general and specific bus problems and could help employees to perform their jobs more effectively and efficiently.

### Driver Involvement in Maintenance Programs

Managers of transit systems interviewed indicated that driver involvement was a key element in the diagnosis of bus problems and, hence, in promoting a successful maintenance program.

A New York State Department of Transportation regulation requires public and private transit operators to direct drivers to turn in a bus defect card at the end of the work shift. These cards include spaces to indicate any bus malfunctions, and sometimes include a space to report bus body damage. Detailed and accurate card reports assist mechanics in determining the repair needs of a particular vehicle.

The Central New York Region Transportation Authority (CENTRO), located in Syracuse, has implemented an innovative program to register driver's post-trip reports. Because CENTRO's management believed that written drivers' reports often did not contain adequate information for mechanics to do the required repairs on the vehicles, a bus reporting booth was constructed as the initial stop of the bus servicing lane at CENTRO's new Syracuse facility. An individual trained to trouble-shoot bus problems is assigned to sit in this booth and to question drivers verbally as they return with the buses to obtain specific and detailed information on any problem(s) the driver had with the bus. This procedure provides more accurate reports and facilitates a more efficient work-flow pattern because it allows each bus to go immediately to the proper area of the garage for servicing. CENTRO is convinced that this system is superior to the card-reporting system utilized by all other operators in the state.

Training drivers in proper bus operation was mentioned by many interviewed transit managers as a desirable means for lengthening bus life because the vehicles last longer when drivers treat the buses with more care. One suggestion to increase the care drivers take with the bus is to pair each driver with the same vehicle every day. Thus, in the same way a driver gets to know the family car, the bus driver would become extremely familiar with the bus and could immediately identify potential problems on a day-to-day basis. In theory, the bus would become the driver's and would be apt to be treated with more care. Many operators reported they would prefer to utilize pairing, but do not have the extra parking space needed to allow a driver to have access to the same bus every day.

## MAINTENANCE PRACTICES

Many characteristics that are unique to each transit system have an effect on the type of maintenance program implemented. Factors influencing maintenance needs include age of the fleet, type of routes the bus runs (express, local, charter), terrain over which the bus runs, climate, number of hours the bus runs per day, and "load factors" (i.e., the number of passengers the bus carries on each run). Each factor influences the types of needed repairs. For example, older buses typically require correction of corrosion damage or engine overhauls, and buses on routes requiring many stops need additional transmission and brake adjustments and repairs.

Certain types of buses require special treatment in order to ensure that they are well maintained. Many transit system managers operating small-sized vehicles contend that these buses require more complicated maintenance than standard-sized buses because of the chassis and body design of smaller buses. Managers also mentioned frequently that advanced-design buses require additional maintenance. Another special case has been the extra maintenance needs created by wheelchair lifts and kneeling mechanisms: lifts and kneelers tend to freeze in cold weather and become inoperable. If not tested once a day, the equipment may not work when needed. The problems of maintaining lifts and kneelers induced Westchester County to develop a demand-responsive paratransit system as an alternative to utilizing the lifts and kneelers on their fixed-route fleet. The New York City Transit Authority has addressed this problem by requiring mechanics who select the job of maintaining wheelchair lifts to stay with this job for 5 years.

### Preventive Maintenance

The preventive maintenance schedules of most questionnaire respondents were based on set mileage intervals. However, several operators utilize schedules based on days (e.g., every other Tuesday, bus 346 is scheduled for a PM). Other properties based PMs on the number of hours a bus was in service. Interestingly, most operators using mileage intervals did not utilize odometers or hubometers as a part of the maintenance program, and relied instead on trip logs to estimate mileage.

The type of preventive maintenance schedule is not as important a factor in PM as is strict adherence to the schedule chosen. If inspections are not

performed as scheduled and mileage intervals between inspections exceed the established schedules, the probability increases that buses will malfunction or break down, creating an unsafe situation for passengers and resulting in a shorter vehicle lifespan.

Manufacturer's specifications for inspection intervals should be used as a basis for the formation of the preventive maintenance schedule with adaptations made at each organization to accommodate unique operating conditions and needs. A written maintenance plan (outlining maintenance goals, PM schedules, and repair policy) helps to clearly identify the procedures and expected results and improves the maintenance effort.

## Performance Measures

Goals for the maintenance program should be based on criteria that are capable of measuring the system's performance. There is a lack of consensus within the transit industry on the most accurate measures of maintenance performance. The questionnaire did not attempt to define the best measures, but was designed to determine which performance measures are currently used by transit properties in New York. Seventeen operators (31 percent of the sample) reported using no criteria, and thus were unable to measure the effectiveness of their maintenance effort. Twenty-six reporting systems utilized mean distance between failure (MDBF), eight used maintenance cost per service mile, two used cost per hour, one used percentage of scheduled trips completed, and one used miles per gallon of fuel.

The utilization of MDBF as a performance measure was considered to be undesirable by many transit managers who were interviewed. A common criticism of the measure was the inconsistent definition of "road call" from property to property. Several systems defined "road call" as any radio call requesting assistance, including those for broken mirrors and windshield wipers; other operators narrowed the term to any mechanical breakdown and still others reported a road call only when a bus was unable to continue in route service.

## Record Keeping

A recurrent situation found during site visits is the need for improvements in record keeping. One measure of the quality of record keeping at a bus system is the ability to determine maintenance cost per bus. A survey question asked if operators compiled records that indicated maintenance costs for each bus. Of 51 respondents, 35 operators reported that they would be able to determine maintenance cost per bus. Nevertheless, site visits revealed records are not always organized in such a manner as to enable the operator to readily determine maintenance cost per vehicle or are not being used efficiently.

Analysis of questionnaire data revealed that there is a correlation between maintenance cost per bus and the percentage of operating cost devoted to maintenance. The mean percentage of operating cost devoted to maintenance was reported to be 18 percent for operators with records kept in such a manner that cost per bus could be determined compared to 26 percent for systems lacking records on cost per bus. Thus, it appears that maintenance efficiency could be enhanced by a record-keeping system capable of reporting maintenance cost for each bus.

Many transit operators have begun to use record-keeping data to strengthen the planning process of their maintenance program. If a system can predict more accurately when a bus component will fail, management may be able to avoid expensive emergency repair by replacing the component before breakdown. As record keeping is expanded to incorporate additional vehicle components, maintenance problems become more predictable and more activities can be added to PM checklists. Replacement of components before failure is not always cost effective. By utilizing vehicle and component records, the operators can compare the cost of the alternative maintenance methods, such as replace-at-failure and replace-before-failure, per component to determine the most efficient method.

## Computer Usage

The computer is an essential part of a records management program, yet only 14 of 54 (26 percent) systems in New York have computerized maintenance programs. Six other systems were in the process of implementing a computerized maintenance system, and 16 systems indicated computerization would be desirable. The larger the system, the greater the propensity for the respondent to report that computerization would be a maintenance aid. Seventy percent of the smaller operators did not believe computerization would benefit their operation because their fleets were small enough that their maintenance programs could be managed manually.

The computer system should provide basic information on buses, maintenance work performed, and PM schedules. Before purchasing a computer, management should assess its objectives and search the market for the proper computer software.

## Diagnostic Techniques

As an aid to proper planning and increased efficiency of maintenance, many operators in the United States take an oil sample from each bus on a regular basis and analyze the sample. The analysis allows managers to determine the optimal time for oil changes and to identify certain engine problems. Significant benefits include an extension of time between oil change intervals, a lengthening of the life of engine coolants, and enhancement of the ability of maintenance personnel to project the life span of engine components.

Diagnostic testing is another preventive maintenance technique. Computerized test equipment to monitor and diagnose bus component problems can often identify minor mechanical problems before major repairs are required. One system currently used is the Automated Bus Diagnostic System (ABDS), which can be used to perform 69 different tests and is designed to reduce unplanned maintenance and to verify that corrections have been made. Siemens, a West German company, has developed a similar diagnostic system that is capable of performing 120 to 170 tests and reducing the time required for inspections. Most bus operators in the United States do not have sophisticated diagnostic equipment because of its cost and the general belief that the equipment is not yet "perfected."

## Contracting Out Maintenance Work

Two surveyed bus organizations contract out all maintenance work and 31 others contract out for some maintenance tasks. The smaller operators were most apt to contract work out because of the lack of facilities or equipment, or both. For example, Upstate Transit in Saratoga Springs, New York, hires a private contractor when major engine work must be done

because it would not be cost-effective for an operator with 43 vehicles to have on hand the equipment necessary for this type of repair. Contracting out maintenance work may be a desirable approach to solving certain problems, but may create additional problems if the contractor is incapable of providing adequate service. One small property that was visited originally contracted out all of its maintenance work to a school bus operator, but discontinued this practice because the quality of the work was poor (e.g., brake shoes were put on backwards). Poorly done work can result in service interruptions and safety problems for transit riders.

### Contract Management

Several municipalities have decided that the best means of providing transit service is to contract out the entire operation to a private operator. Westchester County contracts out all of its bus service to private operators, with Liberty Lines Transit, Incorporated, servicing the greater part of the county. The general principle behind such an arrangement is that a certain level of service is provided by the carrier for a price agreed to in the contract between the municipality and the operator. For example, the Westchester County agreement with Liberty Lines Transit, Incorporated, requires the company to provide the agreed level of service, regardless of the actual cost to the company with a few minor exceptions, such as an unexpectedly rapid rise in fuel costs.

A private operator entering into this type of arrangement has additional incentive to maintain an effective maintenance program to ensure that the profit margin is not eroded by high maintenance costs.

### Parts Procurement and Inventory

Parts availability is important to the planning and efficiency of the maintenance operation. If parts are unavailable, the necessary repair work cannot be completed. A common occurrence during many site visits was that of buses waiting to be repaired because of specific part was not available. This problem occurs for two reasons--the part is too expensive for the property to keep in stock, or planning for inventory levels is inadequate. Relative to the lack of adequate inventory planning, a major problem is insufficient space for inventory, resulting in unorganized parts storage. Several visited operators had to stock parts outside the inventory room in a disorganized pile because of insufficient space, making efficient ordering, receiving, inspecting, locating, and dispensing of parts difficult. A second problem, often related to poor inventory practices, is overstocking of parts resulting from inadequate receiving and inventory control procedures. Valuable inventory space may be lost if parts are ordered without proper monitoring. Many bus systems utilize card systems to keep track of the parts in stock and to determine when to reorder a specific item. Other operators, however, employ computer systems for these purposes. The biggest problem with both methods, revealed by site visits, is the lack of constant updating of information on when parts had been used or reordered, producing incorrect records of inventory levels. It is important that management receive accurate and timely inventory reports to enable realistic projections of parts needs.

Computers are the most desirable method for keeping track of inventory because a large volume of information can be reviewed in a short period of time and part reordering can be facilitated in a timely fashion. Inventory practices also can be influenced by the fleet mix. Having a variety of bus makes and models in the fleet requires the purchase of a greater variety of parts, complicating inventory and its record keeping.

Establishing and following inventory practices proven to be effective is important to ensure that needed parts are available. It was recommended by transit managers and related literature that a locked parts area with access limited to few people be utilized and that a physical inventory of all parts be conducted at least once a year. The best parts procurement systems kept price quotations on file for frequently purchased items obtainable from more than one vendor, thereby allowing the inventory manager to quickly order the needed parts at the lowest price. CENTRO, in Syracuse, has a computer system that prints out price quotations from three vendors when it is necessary to order a specific part.

## SUMMARY

This paper has highlighted the findings of a New York bus maintenance study conducted by the New York State Legislative Commission on Critical Transportation Choices under a cooperative agreement with UMTA. Specifically, the findings relative to the fleet, maintenance facilities, work force, and maintenance practices have been reported.

The commission staff developed a series of 27 specific recommendations, relative to the preceding topics, to improve the effectiveness of bus maintenance practices and preserve the large investment of funds of the federal, state, and local governments in buses and bus maintenance facilities. These recommendations are currently under review by UMTA and the final report should be available in published form in the near future.