SURVEY OF TRANSIT BUS MAINTENANCE PROGRAMS IN VIRGINIA

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ABSTRACT

Transit bus maintenance practices as used by thirteen small and medium-sized transit systems in Virginia were cataloged. Different approaches to maintenance were investigated and the current condition of transit bus maintenance was determined. Factors affecting the performance of transit bus maintenance were identified and recommendations were developed that address the current problems in the maintenance operations of the transit systems studied.

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NEED FOR STUDY

It is generally acknowledged that the maintenance of transit vehicles accounts for approximately 20% of total transit operating expenses.(1) With the increasing complexity of the advanced design buses (ADB) currently being purchased, it is quite likely that the cost of bus maintenance will become an even larger proportion of operating expenses. The changing characteristics of new buses were noted in a recent congressional report which stated that "the ADB does not embody any serious attempt to simplify and make more durable, but rather may be another manifestation of our love affair with complex technology. Like new autos, new buses emphasize features related to style and comfort — often at the expense of durability, maintainability, and fuel economy."(2)

Public transit was for many years a declining industry, but in recent years there has been a steady increase in the demand for public transit services. This increase makes it necessary to operate and maintain more transit buses at a higher reliability rate than in the past, and transit bus maintenance is the most important factor in assuring the present rate of reliability and increasing it in the future. Therefore, the quality and efficiency of transit bus maintenance must be increased in order to provide this reliability. To develop and implement programs to increase quality and efficiency, it is necessary to understand the present condition and practice of transit bus maintenance. Currently, there is no collective body of knowledge or literature dealing with these aspects of transit bus maintenance. The problem addressed by the research reported here is this lack of knowledge and, even more specifically, the lack of knowledge concerning medium and small-sized public transit bus properties and their problems.

A knowledge of the types of organization and practices used by other transit properties will enable a given maintenance manager to improve his assessment of his operations and identify hidden problems that contribute to inefficiency. This is of particular importance where hidden problems may be due to political or other constraints not controlled directly or indirectly by the transit operator.

In recent years, the idea of taxpayer protection has become quite popular. Transit subsidies have thus come under intense scrutiny, and transit vehicle maintenance has taken on added importance as a result of increasing fuel costs and the general inflationary pressures acting on both transit operations and capital purchases. The possibility of improvements in vehicle maintenance has local, state, and national significance. The previously cited congressional report noted that

> On the issue of escalating operating costs, which transit systems and taxpayers nationwide have had to face, it is not enough to dismiss the matter as essentially a local concern. The Federal taxpayer has a considerable interest in the operating side, even beyond the distribution of Section 5 funds that will top the $1 billion level in 1980. It is the local investment in operations and maintenance which protects the Federal capital investment in vehicle procurement. When vehicles are not or cannot be properly operated and maintained, their service life is seriously shortened, meaning replacement vehicles must be purchased with Federal assistance that much sooner. The Federal Government ends up spending more and more for less and less. Conversely, the conduct of the Federally assisted vehicle procurement program has significant effects on the operational burdens imposed on transit operators. To the extent the program tilts procurement toward vehicles which have higher life cycle costs in order to minimize initial costs, it adds to the operations and maintenance burdens at the local level.(2)

There is a growing interest at the federal level in implementing some form of mandatory maintenance requirements for transit vehicles. The idea of federal regulation of vehicle maintenance is not without precedent, as the Federal Aviation Administration enforces a rigorous program of mandatory aircraft maintenance.

The Urban Mass Transportation Administration (UMTA) has made its concern for adequate maintenance of transit buses a matter of public record by statements that appear in the Federal Register.(3) In addition, recent statements by former UMTA Administrator Theodore Lutz indicate that the UMTA is taking a serious look at an increased federal regulatory presence in transit bus maintenance.(4) These statements have been followed up by the UMTA with the advanced notification of proposed rule making for transit maintenance requirements. This notification and eight proposed alternative requirements appear in the Federal Register of January 21, 1981.(5)

The loss of federal funds to support operating assistance at both Section 5 and Section 18 properties now appears to be a certainty. It is, therefore, essential that efforts which assist the operating properties to increase effectiveness and productivity of their vehicle maintenance be given a high priority by the federal, state, and local agencies responsible for public transit.

REPORT FORMAT

The purpose of this report is to provide an overview of research on transit bus maintenance and to catalog transit bus maintenance operations for thirteen small and medium-sized transit properties in Virginia. For the purpose of this report, a small transit system is classified as one with 20 buses or less and a medium-sized system is one with more than 20 buses but less than 250.

This report presents the results of a questionnaire completed by operating properties in the Commonwealth and observations recorded during site visits to the various maintenance operations over a period of five months. The questionnaire results and observations are in turn used as data to develop a description of the maintenance operations which includes facilities, equipment, practices and contracted functions, personnel, organization, information systems, and planning. The elements included in the description are then analyzed to identify factors which affect the performance of transit bus maintenance. These factors provide the information upon which the included set of proposed maintenance standards are based. In addition, there are a number of recommendations, some of which stand apart and some of which are necessary to support the proposed standards.

It is not the intention of this report to evaluate or measure the performance of the reviewed maintenance operations or compare them to one another. The material presented represents what was found in practice and is, therefore, cataloged as such. In the

course of the discussion presented, it will appear that some operations are quite different from others and they are. Each operation is a function of local conditions, operating characteristics, and constraints which prevent and preclude any comparative evaluation.

BACKGROUND

Transit bus maintenance may be characterized as an insurance policy intended to protect the capital investment made when a bus is purchased. It provides the best method of ensuring the mechanical reliability of a transit bus and, in turn, the dependability of that bus in revenue service.

Transit bus failures in revenue service result in delays and perhaps even cancellation of runs, with the effect of eroding the riders' confidence in the system, decreasing the demand for service, and reducing revenues. A mechanical breakdown during revenue service is often accompanied by failure of some allied subsystem of the bus, increased mechanical labor costs, and driver labor costs due to road calls and/or the need to switch buses. When the possible consequences of an in-service bus breakdown are considered, it is easy to support the position that bus maintenance is a worthwhile investment.

Types of Maintenance

Ideally, vehicle maintenance is practiced in three steps: preventive, periodic, and breakdown.

Preventive maintenance can be described as maintenance checks and procedures done on a scheduled and continuing basis throughout the useful life of the vehicle in order to avoid vehicle malfunction during revenue service. It decreases the amount of unscheduled maintenance and provides maximum vehicle availability. In general, preventive maintenance can be thought of as the maintenance of those items that would directly affect the riders' safety or result in a costly unscheduled repair. An example of preventive maintenance is the adjusting of the vehicle brakes at scheduled intervals.

Periodic maintenance is used to assure that major components or parts are maintained or changed when they have been used for a predetermined length of service. An example of periodic maintenance is the replacement of a transmission after 250,000 miles of use.

Breakdown maintenance is used for parts and components that are easily and readily repaired or replaced and pose no safety problem nor require a high cost. Breakdown maintenance would include the replacement of such items as interior light bulbs, reflectors, and exterior lenses.

In the real world, vehicles are maintained under two categories of maintenance effort: preventive maintenance, which is reasonably close to the definition of the ideal practice, and breakdown maintenance, which must be redefined for the real world situation. This new definition includes all maintenance operations performed when there is a failure in any of the components or subsystems of the transit bus, and it is often referred to as "running repair".

Periodic maintenance is not generally practiced by transit properties for several reasons. The data necessary to determine mean failure rates for parts and components are not always available and in most instances are not even collected. If the data are available, they must be reviewed and analyzed, a task that requires a large amount of employee time unless the property is equipped with or has access to a computer and data processing equipment, which is not usually the case.

Approaches to Maintenance

Transit bus maintenance in Virginia is carried out under two basic approaches: (1) the maintenance of transit buses as a part of the fleet of all vehicles owned by a political jurisdiction, and (2) the maintenance of transit buses only in the case of a public owned transit system. These two approaches will be referred to in this report as "municipal fleet" and "transit only".

The local political jurisdiction responsible for the funding of the transit operation must decide which of the two approaches is appropriate for its situation. Each approach has its positive and negative aspects. It should also be mentioned at this point that as a general industry philosophy, the operational aspects of any transit system with more than 15 to 25 buses are usually better suited to the transit only option.

The municipal fleet approach is an effective method of reducing the maintenance facility overhead per vehicle maintained. The large number of vehicles maintained using this approach often makes it cost-effective to purchase expensive maintenance equipment that can not be justified for a small number of buses. This approach allows the maintenance data to be recorded and collected

at one facility and also allows for a centralized inventory if such is desired. These are substantial benefits for a small municipality. However, this approach also can have negative aspects. The wide diversity of equipment that must be maintained often causes a loss of labor productivity. In addition, often a maintenance priority develops in this type of operation, either formally or informally, that positions transit vehicles low on the priority list.

The transit only option is often more costly for a small number of buses, since it requires a duplication of services and facilities that may already exist elsewhere in the political jurisdiction along with additional supervisory and inventory effort. This is balanced by the fact that only transit buses are being maintained, which should allow maintenance personnel to be more productive and better informed about specific problems. In addition, there is no priority to be concerned with as only the transit vehicles are being maintained.

The two basic maintenance approaches can be further divided on the basis of the following five levels of maintenance that can be practiced.

1. Scheduled inspections
2. Minor repairs
3. Replacement of major components and subassemblies
4. Repair of major components and subassemblies
5. Rebuilding of major components and subassemblies

These five levels of maintenance are found in varying degrees in both basic maintenance approaches. The determinant for what level will be practiced is a mixture of the type of maintenance equipment on hand, skill of the maintenance personnel, and cost of the operation. The last ingredient in the mixture, cost, is the one least defined or understood, because adequate cost data concerning rebuild, repair, or replace are rarely, if ever, maintained.

METHODOLOGY

The study comprised the following tasks.

1. A review of the available literature dealing with transit bus maintenance.

2. A direct mail questionnaire of the operating properties listed in Table 1.

3. Site visits to each of these operating properties.

4. An examination of the information obtained from the survey and site visits.

5. The preparation of a final report documenting the findings of the study.

Table 1

Virginia Operating Properties That Were Reviewed

Richmond Transit
Tidewater Regional Transit
Peninsula Transit
Roanoke Transit
Lynchburg Transit
Charlottesville Transit
Petersburg Transit
Danville City Transit
Bristol City Transit
Staunton Transit
Winchester Transit
James City County Transit
Harrisonburg Transit

NOTE: See Appendix A for bus inventories of these properties.

LITERATURE REVIEW

The amount of literature available on transit bus maintenance is relatively small compared to that on other transportation subjects. This is a deplorable situation when one considers that approximately 20% of public transit operating expense is a direct result of vehicle maintenance. The literature that is available can be classified into four groups. The first deals with maintenance scheduling and improved information systems for maintenence operations in transit properties.[6,7,8,9,10] The second relates to preventive maintenance activities, forms, and mileage schedules either in use or recommended for use by various transit properties and state agencies.[11,12,13] The third is concerned with overall transit system service evaluation and includes publications that may or may not contain some cursory evaluation of the vehicle maintenance operation.[14,15,16,17,18,19,20,21,22] The fourth classification is made up of literature dealing with vehicle maintenance at the operational level.[23,24,25,26,27,28]

The literature reviewed is discussed under these four classifications below.

Maintenance Scheduling and Information Systems

Bakr and Kretschmer[6] discuss the need for an optimal schedule of bus maintenance from a least-cost point of view. A method of determining a least-cost schedule is developed and presented as a means to balance the cost of maintenance against the cost resulting from unscheduled repairs due to mechanical failure.

Herniter et al.[7] present a model called MASSTRAM to be used in analyzing alternative maintenance strategies for rail vehicles to balance the cost of maintenance against lost service. The model is, in effect, a planning tool and not a method for arriving at a precise maintenance schedule.

The International Business Machine Corporation[8] and the Mitre Corporation[9] present descriptions of information systems designed for the processing of maintenance and repair data to improve the productivity of the maintenance function.

Activity Forms and Mileage Schedules

The Transit System Maintenance Manual[11] prepared for the Florida Department of Transportation is presented as a guide for newly created transit systems with a fleet of 25 or more buses. Meant to be an aid to the development of maintenance facilities and activities, it covers tools and equipment, inventory control, preventive maintenance, recommended service procedures and intervals, sample forms, personnel, safety, and training.

Preventive Maintenance — Forms and Procedures[12] is another example of this type of literature. It is a collection of preventive maintenance reporting forms and the type of schedules used by various transit properties. Much of this information was reprinted from the previously cited Florida manual.[11]

The Coach Inspection Manual[13] developed by the Washington State Department of Transportation is a collection of example inspection forms to be used in conjunction with preventive maintenance procedures. It explains how to perform 56 maintenance item checks, adjustments, and replacements.

Transit System Evaluation

Typical examples of this type of literature are Allen and Grim[14] and Mundle and Cherwony.[15] These papers present the

development and explanation of overall system performance indicators, of which those for vehicle maintenance are minimal as compared to service indicators. The developed indicators are applied as internal measurements and not as external or peer comparisons.

Fielding and Glauthier[16] and Holec et al.[17] present system evaluation techniques to be used for external comparisons. Here again, emphasis is on service evaluation, with vehicle maintenance receiving only minimal attention. Holec does show the validity of using Section 15 Data as performance data.

Much of the material reviewed was completely service oriented and did not include vehicle maintenance measures. The studies of Flusberg et al.[20] Attanucci et al.[21] and Drosdat[22] are examples.

Operational Areas

McKnight et al.[23] are investigating the connections and relationships among transit vehicle maintenance, service reliability, and travel demand.

Holthoff and Knighton[24] have investigated cost increases, cost differences, and productivity in several New York transit systems. The objectives of their study were to explain rising operating costs and the reasons why some transit properties are more costly to operate than others. Causes such as average vehicle speed, labor cost, and productivity were identified as problem areas.

A paper by Haenish and Miller[25] presents information on how to devise improved procedures that lead to increases in productivity.

Thurlow et al.[26] present the results of a survey made to obtain information for cataloging and detailing trends in transit bus maintenance facilities. The report discusses the construction of garage and shop buildings, floor plans, tools and equipment, and maintenance personnel necessary to fulfill the maintenance requirements for fleets of various sizes.

Forester et al.[27] discuss a study in which the previously referenced MASSTRAM model was adopted for transit bus use and an attempt was made to implement the model in conjunction with the Chicago Transit Authority. General transit maintenance planning is also explored. Major findings of the study are that there is a

gap between maintenance theory and practice, there is inadequate collection of data suitable for transit maintenance planning, and current maintenance schedules are almost always arrived at by using manufacturers' recommendations and operator experience. Two major recommendations are that current practices and procedures be documented and that a federal policy on maintenance planning be developed.

The Utah Transit Authority[28] presents the results of a questionnaire survey conducted by mail to obtain information on transit bus maintenance practices and schedules. The 44 transit bus properties responding provided data on scheduled maintenance, servicing, training, repair maintenance, and general maintenance. Examples of maintenance inspection schedule sheets used by various properties are included in the report. A major conclusion of this study supports the idea that there is a lack of research on the maintenance practices of transit operators.

MAIL QUESTIONNAIRE

A questionnaire was mailed to maintenance management personnel at each of the thirteen Virginia properties participating in the study. All of the questionnaires were completed and returned. This document elicited information on maintenance facilities, maintenance personnel, maintenance procedures, maintenance problems, bus purchases, and cooperative efforts. As in any survey, the completeness of the responses varied but, in general, the range was good to excellent. A copy of the questionnaire, including tabulated responses, is presented in Appendix B.

Questionnaire Results

The main results in these six areas are discussed in this section and, for ready reference, are included in the responses presented in tabular form.

Maintenance Facilities

Table 2 presents the main responses for this subject area. One maintenance facility was used for the support of transit bus operations at each of the respondent properties. While several properties had various functions of the maintenance activity housed in different buildings, these all were located at the same site and were, therefore, considered to be one facility. The ages of the

facilities ranged from 1 to 80 years, with the mean age being approximately 35 years. Maintenance equipment is also included in this subject area. The amount of maintenance equipment available was considered adequate by 7 respondents and inadequate by the remaining 6. The type of maintenance equipment available was judged adequate by 5 respondents and inadequate by 8.

Table 2

Questionnaire Results — Maintenance Facilities

Age of the Maintenance Facility	No. Years	No. of Responses	% Total
	1	1	8
	2	1	8
	13	1	8
	20	1	8
	30	2	15
	35	2	15
	40	1	8
	54	1	8
	75	1	8
	80	1	8

	Yes		No	
	No. of Responses	% Total	No. of Responses	% Total
Amount of maintenance equipment adequate	7	54	6	46
Type of maintenance equipment adequate	5	38	8	62

NOTE: All properties reported having one maintenance facility.

Maintenance Personnel

The main responses in this subject area, presented in Table 3, relate to turnover, employment, and training. It was indicated that the annual turnover rate for maintenance personnel ranged from zero to 10.0%, with the mean being 2.6%. The rate for service personnel

was between zero and 17.0% with a mean of 2.4%. Twelve of the respondents, about 92%, indicated that it was difficult to attract and employ qualified bus maintenance personnel, while 1 did not experience such difficulty. The respondents were unanimous in their expressed need for some sort of formal in-state, training programs for Virginia transit bus mechanics. While the response to the relative need for training was unanimous, only 2 of the systems had an organized in-house training effort and 4 indicated that they had an in-house apprentice program.

Table 3

Questionnaire Results — Maintenance Personnel

	Rate %	No. of Responses
Maintenance personnel turnover	0	5
	1	2
	2	1
	3	1
	7	1
	10	2
Service personnel turnover	0	8
	1	2
	2	1
	10	1
	17	1

	Yes		No	
	No. of Responses	% Total	No. of Responses	% Total
Difficulty in hiring qualified maintenance personnel	12	92	1	8
Formal transit maintenance training needed in Virginia	13	100	-	-
Formal training program	2	15	11	85
Organized apprentice program	4	31	9	69

Maintenance Procedures

Maintenance capability, contract work, vehicle records, maintenance schedules, and the levels of maintenance are the main categories included under maintenance procedures. These responses are presented in Tables 4 through 6.

Six properties indicated that they had complete in-house maintenance capability and 7 felt that their capability was less than complete. The need for more in-house capability was expressed by 8 of the respondents, while the other 5 felt they did not need more capability.

The practice of contracting out service work was used by 4 respondents and maintenance work was contracted out by 5. Component and subassembly rebuild work was the largest type activity put out to contract. Ten properties indicated that they did contract out rebuild work and only 3 did not.

All of the respondents indicated that they had a system of vehicle maintenance records of some kind, with 3 of the systems responding that their maintenance records were computerized.

A preventive maintenance program was being used by 12 properties, while 1 property indicated it did not. The 12 respondents that operate a preventive maintenance program all indicated that their programs were based on vehicle use in miles. In addition, 1 respondent indicated that certain maintenance procedures were scheduled on a seasonal basis. The indicated mileage interval used for the basic preventive maintenance schedule ranged from 1,500 to 6,000 miles, with the mean for the 12 properties being approximately 3,770 miles.*

The percentages of total maintenance reported to be preventive maintenance ranged from 20% to 80%, with a mean of 46.9%. The same figures also appear for the percentages of maintenance work that reported to be remedial. While the range and the mean 45.5 are almost identical, the distribution was quite different as shown in Table 5. In addition, routine component change out and subassembly replacement were practiced by only 3 properties.

As indicated, 6 of the respondents classified their remedial maintenance as being 50% or more of total maintenance. Remedial maintenance (running repair) is more costly to undertake than other types. The repair and replacement of major components and subassemblies is obviously more expensive than actions usually associated with preventive maintenance. In addition, remedial maintenance requires that the bus be kept out of revenue service for longer periods of time than does scheduled preventive maintenance. When large amounts of remedial maintenance are necessary to meet service levels, the result is that less time and manpower

*In the interest of readability, the metric equivalent of the mile is stated here and not repeated in the text and tables.

are available for preventive maintenance. Deferring necessary preventive maintenance causes still more failures, which in turn increase the amount of remedial maintenance.

Ten maintenance tasks were listed in the questionnaire. Five of these were commonly done by all the respondents. The scheduled inspection of vehicles and the repair of major components were being done by 12 properties. Three of the five most common tasks — minor repairs and replacement, replacement of parts, and replacement of major components — were being done by all the respondents. These results are presented in Table 6.

Table 4

Questionnaire Results — Maintenance Capability, Contract Work, Vehicle Records, and Maintenance Schedule

	Yes		No	
	No. of Responses	% Total	No. of Responses	% Total
Complete in-house maintenance capability	6	46	7	54
Need added in-house maintenance capability	8	62	5	38
Service work contracted out	4	31	9	69
Maintenance work contracted out	5	38	8	62
Rebuild work contracted out	10	77	3	23
Vehicle maintenance record system	13	100	-	--
Record system computerized	3	23	10	77
Preventive maintenance program in use	12	92	1	8
Preventive maintenance program based on mileage	12	92	1	8

	Miles	No. of Responses	% Total
Mileage interval used for preventive maintenance schedule	(none)	1	8
	1,500	1	8
	2,000	2	15
	3,000	2	23
	4,000	1	8
	4,500	1	8
	5,000	1	8
	6,000	4	31

Table 5

Questionnaire Results — Maintenance Activities
by Major Type

	%	No. of Responses
Portion of maintenance work that is preventive	20	2
	25	2
	33	1
	40	1
	45	1
	50	1
	70	1
	75	1
	80	2
	no comment	1
Portion of maintenance work that is remedial	20	4
	30	2
	50	1
	55	1
	66	1
	75	1
	80	2
	no comment	1
Portion of maintenance work that is of other type	0	6
	5	2
	10	1
	20	1
	25	2
	no comment	1

	Yes		No	
	No. of Responses	% Total	No. of Responses	% Total
Regularly scheduled component change outs	3	23	10	77

Table 6

Questionnaire Results — Maintenance Activities by Work Task

Maintenance Tasks	Yes		No	
	No. of Responses	% Total	No. of Responses	% Total
Scheduled inspection	12	92	1	8
Minor repairs & replacements	13	100	-	--
Replacement of parts	13	100	-	--
Replacement of major components	13	100	-	--
Repair of major components	12	92	1	8
Rebuild of major components for stock	7	54	6	46
Replacement of subassemblies	9	69	4	31
Repair of subassemblies	7	54	6	46
Rebuild of subassemblies for stock	5	38	8	62
Body and chassis structural work	8	62	5	38

Defect Reporting	Written Form		Verbal		No Set Procedure	
	No. of Responses	% Total	No. of Responses	% Total	No. of Responses	% Total
Operators	10	77	2	15	1	8
Service personnel	8	62	3	23	2	15

The five remaining tasks were being performed by a smaller number of the respondents. The rebuilding of major components and the repair of subassemblies were being done by 7 properties. Nine properties reported that they replaced subassemblies while only 5 rebuilt subassemblies for stock. The final maintenance task, body and chassis structural work, was done by 8 properties.

Defect reporting was the last subject covered in the questions on maintenance procedure. Ten of the respondents indicated the vehicle operators reported vehicle defects to the maintenance personnel on a written form, 2 indicated that they used verbal reporting, and 1 had no set procedure. Vehicle service personnel in 8 properties

used a written form to report defects to the maintenance personnel, 3 properties reported these verbally, and 2 had no set procedure.

Maintenance Problems

Most of the maintenance problems cited by the respondents related to the kind of operation and the type of vehicle. These are presented in Table 7.

Six of the responding properties indicated that they experienced maintenance problems peculiar to their operations. These included a very short service life for brake linings and tires caused by hilly terrain in their operational area. Transmission failures, and the attendant road calls, were also attributed to the terrain over which the properties operated. Various problems resulting from inadequate maintenance facilities and equipment were cited. Several properties cited problems with limited manpower and mechanical ability as being related to their kind of operation.

Table 7

Questionnaire Results — Maintenance Problems

	Yes		No	
	No. of Responses	% Total	No. of Responses	% Total
Maintenance problems relating to kind of operation	6	46	7	54
Maintenance problems relating to type of vehicle operated	10	77	3	23

A much larger group, 10 respondents, noted problems being experienced as a direct result of the type of transit vehicle they were operating. These responses indicated considerable problems with vehicles that were no longer being marketed in the United States and vehicles for which major components and subassemblies were no longer available from the manufacturer. Certain foreign manufactured buses were singled out as a major source of problems, along with small-sized domestic vehicles that were not

holding up very well in daily revenue service. An additional major source of problems indicated was the high rate of component and system failures experienced while operating advanced design buses, irrespective of the bus manufacturer. Specifically cited were failures of the air conditioning equipment, electrical components, brake system, wiring, engine accessories, and the automatic transmission. It appears that failures were found in all the major systems necessary for the operation of the bus. These failures were noted to have led to an increased amount of running repairs and in-service breakdowns resulting in costly road calls.

Bus Purchases

The information obtained on bus purchases is presented in Table 8. Ten properties said they expect to purchase new buses within three years. The numbers of buses to be purchased by the properties ranged from 1 to 47 and totaled 118.

Eleven of the respondents felt that the buses available were compatible with their present maintenance operations. A smaller number, 7 respondents, felt that the bus manufacturers were providing adequate technical assistance.

Questions relating to spare buses were also included in this section of the questionnaire and the responses are shown in Table 9. The percentages of total bus fleets indicated as spares by the respondents ranged from 9% to 40%, and the mean value was approximately 20%. Nine of the respondents felt that a certain percentage of the fleet should be spares and their figures ranged from 15% to 40%, with a mean of approximately 25%. The other 4 properties related the number of spares to the size of the operation, type of operation, maintenance capability, etc., and not to some percentage of the fleet alone.

In responding to the last question in this area, which concerned the procurement of tires for the transit vehicles, 7 of the operations said that they leased the tires and the others said they purchased them.

Cooperative Effort

The questions under this heading contain the term "statewide cooperative". The definition of this term, in the questionnaire, is open-ended, the intent being to gain information concerning the concept of these cooperative approaches, not any particular program. The responses to the group of questions are presented in Table 10.

Table 8

Questionnaire Results — Bus Purchases

	Yes		No	
	No. of Responses	% Total	No. of Responses	% Total
Purchase new buses within 3 years	10	77	3	23

Bus Purchases	Number of Buses	Number of Properties	Subtotal of Purchases
	0	3	0
	1	1	1
	3	1	3
	4	2	8
	5	2	10
	8	1	8
	11	1	11
	30	1	30
	47	1	47
Total Number of Buses to be Purchased			118

	Yes		No	
	No. of Responses	% Total	No. of Responses	% Total
Available buses are compatible with existing maintenance operation	11	85	2	15
Bus manufacturers are providing adequate technical assistance (One respondent would not comment on this question)	7	58	5	42

Table 9

Questionnaire Results — Spare Buses

	% Fleet	No. of Properties
Percentage of fleet that are spares	9	1
	10	1
	11	1
	14	1
	15	1
	20	2
	22	1
	30	1
	31	1
	33	1
	35	1
	40	1
Percentage of fleet that should be spares	15	1
	20	4
	30	1
	33	1
	35	1
	40	1

NOTE: 4 respondents felt this figure should float depending on the local circumstances.

	Purchase		Lease	
	No. of Responses	% Total	No. of Responses	% Total
Procurement of transit bus tires	6	46	7	54

Table 10

Questionnaire Results — Cooperative Efforts

	Yes		No	
	No. of Responses	% Total	No. of Responses	% Total
Cooperative purchase of parts and supplies	6	46	7	54
Cooperative rebuilding of components and subassemblies	7	54	6	46
Cooperative purchase of transit buses	8	62	5	38

The cooperative purchase of parts and supplies used for bus maintenance was felt to be a possible asset by 6 of the properties, and the cooperative rebuilding of components and subassemblies was seen as an asset by 7. The largest positive response was registered for the idea of cooperative bus purchase, with 8 properties feeling this would be an asset.

SITE VISITS

The site visits were made after the questionnaires had been returned so that survey responses could be discussed and clarified if necessary during the visits. Information was obtained on maintenance facilities, equipment, practices and contracted functions, personnel, organization, information systems, and planning.

The observations and the information obtained during the site visits are presented in two parts corresponding to the basic vehicle maintenance approaches of municipal fleet and transit only, which were discussed in the BACKGROUND section of this report.

Municipal Fleet

The operating systems in this group range in size from 3 to 11 buses, as seen in Table 11. As indicated, the systems in Bristol and Staunton did not precisely fit into this category. The Staunton system was a transit and school bus maintenance operation but was in the process of becoming part of a municipal fleet. The system in Bristol is also a combined school bus and transit bus maintenance operation and has a larger number of school buses than transit buses.

Table 11

Municipal Fleet Systems

System	Number of Buses
Danville Transit	10
Bristol Transit*	9
Staunton Transit*	8
Winchester Transit	11
James City County Transit	5
Harrisonburg Transit	3

*These two properties do not entirely merit the definition of municipal fleet systems.

In addition, the transit operation of both of these systems was small, less than 10 buses, and this fact made them operationally more similar to the municipal fleet system than the transit only.

Maintenance Facilities

The general condition of the maintenance facilities of this group was good. Obviously, some were better organized and cleaner than others, but all appeared to be reasonably well maintained. However, there were several items that warrant comment.

It was found that the maintenance facility in several of these operations was undersized for the type of vehicles being used or expected to be used in the near future. This observation is based on information contained in Thurlow et al.[26]

The service and maintenance of transit buses is a much more time-consuming and physically difficult task when the maintenance facility is inadequate, especially when vehicle lifts and/or floor pits of suitable size are not provided. None of the systems had an inspection pit adequate for transit bus work and only Bristol, Staunton, and James City County had adequate lifts. None had drive-through bays, automatic wash equipment, or automatic vacuum equipment, although Danville was purchasing the wash equipment.

Maintenance Equipment

The amount and type of maintenance equipment needed by an operating system are a function of the areas of maintenance engaged in and the level of intensiveness. The maintenance equipment available at these systems ran the range from obsolete to new, with the majority falling in the category of used but in good condition. Decisions concerning purchases of capital equipment for maintenance are a local responsibility and must be determined using site-specific information. There are, however, minimal requirements for operating with any degree of effectiveness. The types of equipment required are indicated in Table 12. Most of the municipal fleet systems had this minimum as well as additional equipment necessary for their operation.

Table 12

Minimum Maintenance Equipment for Municipal Fleet

Portable jacks	Steam cleaner
Hydraulic Jacks	Capacity to clean parts
Work benches and vises	Wheel dolly
Arbor press	Tire inflation gage or guard
Drill press	Torque wrenches
Air compressor	Multimeter for electric testing
Electric & gas welding equipment	Chain hoist

Maintenance Practices

It was mentioned that the levels of maintenance engaged in vary among systems. That is the case with this group as can be noted in Table 13. All of the fleets engaged in the first five practices, except that Bristol and Harrisonburg did not do scheduled inspections. While all but these two made regularly scheduled preventive maintenance inspections, the contents and procedures of the inspections differed.

Danville, Staunton, and Winchester used the same inspection procedure for all types of vehicles, while James City County used a separate inspection procedure for transit vehicles. The elements of the inspections being performed are presented in Table 14, which includes the types of transit vehicles. This table clearly illustrates that different types of vehicles have different needs as far as preventive maintenance schedules are concerned. Copies of the inspection forms used by these systems are included in Appendix C.

Table 13

Maintenance Practices of Municipal Fleets

Practice	Danv.	Bris.	Stau.	Winc.	Jacc.	Harr.
Scheduled inspections	X		X	X	X	
Minor repairs	X	X	X	X	X	X
Replacement of parts	X	X	X	X	X	X
Replacement of major components	X	X	X	X	X	X
Repair of major components	X	X	X	X	X	X
Rebuild of major components for stock		X				
Replacement of subassemblies	X	X	X	X	X	X
Repair of subassemblies	X	X	X	X	X	X
Rebuild of subassemblies for stock						
Body and chassis structural work	X		X	X		

The major components of a typical transit bus and the properties making repairs of these components are presented in Table 15.

Variations among the fleets were attributable to the skill level of the mechanics, type of maintenance equipment available, time required to make the repair, and local operating philosophy. Costs should be included in this list and would be if reliable data for determining costs had been available. Nevertheless, cost is considered in many decisions, most of which are arrived at subjectively on the basis of experience.

Note that James City County is not included in Tables 15 or 16. Until very recently, it had contracted out all of its maintenance and repair work but with the completion of a new municipal fleet facility, it was beginning to perform its own maintenance.

Another important aspect of vehicle maintenance practice is the rebuilding of major components and subassemblies. This activity is the one least often done in-house. Work contracted out can be of the repair variety, but the largest portion is component or subassembly rebuilding. Information concerning contracted work is presented in Table 16.

Table 14

Preventive Maintenance Items and Mileage Schedules
for Municipal Fleets

(I) Inspect (R) Replace	Danville GMC T6H 4523A TDH 4517 TDH 3714	Staunton GMC TDH 3302A	James City Cty. Mercedes Benz 309D	Winchester School Bus Gasoline Type
Chassis Lube	3,000	1,500	15,000	2,000
(R) Eng. Oil	3,000	3,000	5,000	2,000
(R) Oil Filt.	3,000	3,000	5,000	2,000
(I) Oil Press.		1,500		
(I) Air Filt.	3,000	3,000	5,000	2,000
(R) Air Filt.			15,000	
(R) Fuel Filt.			15,000	
(I) Belts, Hoses	3,000	1,500	5,000	2,000
(I) Exh. Sys.	3,000		5,000	2,000
(I) Coolant	3,000	1,500	5,000	2,000
(I) Trans. Oil	3,000	1,500	5,000	2,000
(R) Trans. Oil	10,000		20,000	
(R) Trans. Filt.	10,000		20,000	N/A
(I) Drive Line	3,000	1,500	10,000	
(I) Diff. Oil	3,000	1,500	5,000	2,000
(R) Diff. Oil			30,000	
(I) Adj. Brks.	3,000	1,500		
(I) Brk. Lining	3,000	1,500	15,000	5,000
(I) Emg. Brk.	3,000	1,500		2,000
(I) Air Sys.	3,000	1,500		N/A
(I) Air Comp.	3,000	1,500		N/A
(I) Tanks, Lines	3,000	1,500	5,000	N/A
(I) Starter	3,000			2,000
(I) Alt. Output	3,000	1,500		
(I) Batteries	3,000	1,500	5,000	2,000
(I) Lights	3,000	1,500	5,000	2,000
(I) Gages, Instrs.	3,000	1,500		2,000
(I) Steering	3,000	1,500	5,000	2,000
(I) Suspension	3,000	1,500	5,000	2,000
(I) Whl. Brgs.	3,000		10,000	2,000
(I) Tires	3,000	1,500	5,000	2,000
(I) Body	3,000	1,500		
(I) Wpr., Wash.	3,000	1,500	5,000	2,000
(I) Ht., Def.	3,000	1,500		2,000
(I) Air Cond.	3,000		N/A	N/A
(I) Door Opr.	3,000	1,500	5,000	
(I) Windows	3,000	1,500		2,000
(I) Seats	3,000	1,500		
(I) Horn	3,000	1,500		
(I) Mirrors	3,000	1,500	5,000	

Table 15

In-House Repair of Major Components
by Municipal Fleets

	Danv.	Bris.	Staun.	Winc.	Harr.
Air System					
Compressor		X			
Valves		X			
Electrical Equipment					
Alternator/generator	X	X	X	X	X
Starting motor	X	X	X	X	X
Radio	X	N/A		N/A	
Engine					
Head, block, and crankshaft machining					
Valve and seat machining					
Valve seat and guide replacement					
Cooling system	X	X	X	X	X
Blower	X	N/A	N/A	N/A	N/A
Fuel injectors				N/A	N/A
Automatic Transmission					
Major repairs	X	X			
Assembly for rebuild	X	X			
Heating and Air Conditioning					
Compressor		N/A		N/A	N/A
Controls	X	X	X	X	X
Blower motors	X	X	X	X	X
Marine pumps	X	X	X	N/A	N/A
Plumbing	X	X	X	X	X
Brakes					
Drums				X	X
Lining	X	X	X	X	X

Table 16

Work (Rebuild) Contracted Out by Municipal Fleets

	Danv.	Bris.	Staun.	Winc.	Harr.
Air System					
Compressor	X		X	X	N/A
Valves	X		X	X	N/A
Electrical equipment					
Alternator/generator	X		X	X	X
Starting motor	X		X	X	X
Radio		N/A	X	N/A	X
Engine					
Head, block, and crankshaft machining	X	X	X	X	X
Valve and seat machining	X	X	X	X	X
Valve seat and guide replacement	X	X	X	X	X
Water pump	X	X	X	X	X
Blower	X	N/A	N/A	N/A	N/A
Fuel injectors	X	X	X	N/A	N/A
Assembly for rebuild			X	X	X
Automatic Transmission					
Major repairs			X	N/A	X
Assembly for rebuild			X	N/A	X
Heating and Air Conditioning					
Compressor	X	N/A	X	N/A	N/A
Controls	X	X	X	X	X
Blower motor	X		X	X	X
Marine pump	X		X	N/A	N/A

As expected, the rebuilding tasks that require a maximum amount of skill and investment in capital equipment are those most frequently contracted out. These include engine machining of all types, complete engine rebuilding, fuel injector rebuilding, alternator and starting motor rebuilding, and automatic transmission repairs and rebuilding.

Information on the final maintenance practice, vehicle servicing, is presented in Table 17. These actions are performed by all the systems in this group and the individual service items are performed in basically the same manner but with differing frequencies.

Table 17

Vehicle Servicing by Municipal Fleets

D - Daily
BW - Biweekly
W - Weekly
AN - As Needed

	Danv.	Bris.	Staun.	Winc.	Jacc.	Harr.
Fueled	D	D	BW	D	D	D
Fluid check	D	D	BW	D	D	D
Visual check	D	D	D	D	D	D
Exterior washed	W	W	AN	W	AN	D
Interior swept	W	D	D	D	D	D

Maintenance Personnel

With the exception of Bristol and Staunton, neither of which are true municipal fleets, none of the fleets have maintenance personnel dedicated to the maintenance of transit vehicles. It was observed that several of the systems in this group even rely on the vehicle driver to clean the interior of the bus and provide the usual daily services.

For the most part, the personnel engaged in maintaining transit buses were not transit bus mechanics. Very few had had experience in transit bus maintenance before being employed or had received training in such maintenance following their employment. The present generation of transit buses cost, on average, approximately $140,000, and are equipped with several complex subsystems. Maintaining them requires a thorough understanding of the subsystems and a high level of technical ability, both of which are best obtained through some form of organized training or apprentice programs, not through a trial and error learning approach using expensive operating equipment as the practice medium.

During each of the site visits, the maintenance personnel expressed a need for training. In spite of this unanimous expression of need, none of the systems had an organized training program. All of the systems did, however, encourage their maintenance employees to seek out and obtain training on their own time. As an incentive, the cost of tuition, textbooks, and necessary materials for this usually was paid for by the system when the employee successfully completed the course. This approach, although better than none, shifts the responsibility to the individual employee and away from management. In addition, the opportunity to get this type of training is very limited throughout most of the state.

It was observed that most of the maintenance employees seemed to be reasonably pleased with their jobs. In general, relatively little labor turnover was found, probably more because of the fringe benefits and employment security than the basic wage rate. In fact, for this group of operating properties the hourly wage ranged from $3.25 for helpers to $7.50 for skilled mechanics. These rates are controlled by each municipality as part of the total municipal salary scale and are based on experience, training, and local conditions, and are usually somewhat lower than those paid in the private sector.

Maintenance Organization

There is no organization of personnel by function in the six properties in this group, and each mechanic is assigned tasks depending on what function needs to be done at a given time. Although there is no organization by function, there is a priority ranking for undertaking the various maintenance operations, as shown in Table 18. Road calls, and their resultant emergency repairs, along with essential running repairs are given top priority. The number of road calls and running repairs made by several of the systems were high and could be directly attributed to vehicle age, vehicle type, and deferred preventive maintenance. These activities limit the amount of preventive maintenance that can be accomplished, and as a result large amounts of breakdown maintenance must be done to meet scheduled runs. Breakdown maintenance of this type is far more costly than scheduled preventive maintenance and further erodes the effectiveness and efficiency of the maintenance operation.

An even further deterioration of transit vehicle maintenance results from setting maintenance priorities on the basis of vehicle type. A typical priority list for maintaining municipal equipment might be similar to that in Table 19. Obviously, transit vehicles should not receive maintenance priority in the case of an emergency or when dealing with emergency equipment that is in very short supply; however, it is necessary to keep in mind that there is a substantial investment in transit vehicles that must be protected at an appropriate level.

Table 18

Priority of Maintenance Functions in Municipal Fleets

Function	Priority
Road calls	1
Running repairs	1
Preventive maintenance	2
Rebuild	3

Table 19

Maintenance Priority by Vehicle Type in Municipal Fleets

Vehicle Type	Priority
Emergency (ambulance, rescue vehicle, etc.)	1
Police vehicles	2
Fire equipment	3
Refuse equipment	4
Public works equipment	5
Transit buses	6

Vehicle Maintenance Management Information System (VMMIS)

The purpose of the VMMIS is to strengthen and assure the maintenance administration function by providing a management aid that will adequately support maintenance planning and operational requirements. In general, a VMMIS is composed of three parts: data collection (maintenance forms), data manipulation and analysis, and useful output of an operational and reporting nature. While it is possible to operate a VMMIS as a manual system without a computer, it is very labor intensive to do so.

None of the systems in the municipal fleet group operated a VMMIS. It is true that several did have cost information and inventory control functions, some of which were computerized, but none were attempting to consolidate and analyze data on the operational aspects of vehicle maintenance for the purpose of improving maintenance productivity.

The foundation of any VMMIS is the various data collection forms. The properties in this group use a variety of these as indicated in Table 20, which lists only the written forms completed or controlled by the maintenance operation. Therefore, it is possible for a certain type of information to be collected or to be accessible elsewhere in the overall transit organization and not be immediately available to the maintenance people. Copies of the various forms used by the municipal fleet systems are given in Appendix D.

The data necessary to implement a VMMIS, such as the types in Table 21, are often available within the transit system organization or could be collected with relatively little effort. The data that were collected were almost never being analyzed except for use in cost accounting and inventory control. This information usually was not being returned to the maintenance administration level in any form useable for planning the preventive or periodic approach that should be taken. Unfortunately, several kinds of data that are very important to maintenance management such as those on road-call failures, buses out of service, detailed labor time, etc., were not being collected by a majority of the systems.

Table 20

Maintenance Information Forms in Use by Municipal Fleets

	Danv.	Bris.	Staun.	Winc.	Jacc.	Harr.
Operator defect or inspection sheet	X	X		X	X	X
Daily fuel, oil, and fluid use record		X	X			
Preventive maintenance inspection sheet	X		X	X	X	
Road call record				X		
Repair order	X	X			X	X

Table 21

Maintenance Data Recorded by Municipal Fleets

	Dan.	Bris.	Staun.	Winc.	Jacc.	Harr.
Labor	X		X	X	X	X
Parts	X	X	X	X	X	X
Type of repair	X	X	X	X	X	X
Mileage	X	X	X	X	X	X
Oil use	X		X	X	X	X
Fuel use	X		X	X	X	X
Road calls				X		
Missed runs due to maintenance						
Late runs due to maintenance						
Component failures						
Subassembly failures						
Buses down for maintenance						

It was also observed that even when data were available there was no attempt to generate performance indicators or measures for internal or external comparison as a means of maintenance accountability. This lack of performance measures was also linked to the general absence of any stated or written goals and objectives for the maintenance operations in all of the municipal fleet systems.

Maintenance Planning

A program of planned transit vehicle maintenance is based on fixed schedules for maintenance practice on a reoccurring cycle. "In the broadest interpretation, its goal is to minimize total cost, including those for maintenance labor, parts, road calls, spare vehicles, loss of service, and management information requirements."(23)

The municipal fleets did not make much use of maintenance planning to formulate the best preventive and periodic maintenance schedules based on local conditions. It was observed that the common method of planning the schedule and level of maintenance was to rely on the manufacturer's recommendation and operating experience. Another approach was to continue the maintenance program used by the preceding private transit operator.

The bases used in maintenance planning noted during the case studies are presented in Table 22, where it is readily seen that the level of maintenance planning is not impressive. There are three major causes for this lack of planning activity: the size of the operations, a sense of immediacy about the maintenance that is performed that overshadows any thoughts or attempts at planning, and the lack of data in usable form or a system approach to use the data that are available. The effect of each of these is heightened by the absence of any goals and objectives for the maintenance operations.

Table 22

Bases of Maintenance Planning Activity for Municipal Fleets

	Danv.	Bris.	Staun.	Winc.	Jacc.	Harr.
Goals and objectives						
Manufacturers' recommendations	X		X	X	X	
Operating experience	X					
Data collection						
Accessible data						
Data analysis						
Vehicle profiles						
Component failure trends						
Subassembly failure trends						
Performance indicators and measures						

Summary

The general findings from the visits to the municipal fleet systems are reflected in the list below. Not all of these characteristics are applicable to each of the municipal fleet operations; however, all are negative factors that diminish maintenance productivity.

1. The facility is undersized.
2. The facility is improperly equipped.
3. The maintenance operation is incorrectly staffed.
4. The maintenance employees are in need of initial or additional training.
5. Equipment maintenance priority practices do not favor transit vehicles.
6. Breakdown maintenance receives priority over preventive maintenance.
7. There is a lack of goals and objectives in the maintenance areas.
8. There is a lack of locally developed and implemented performance indicators for maintenance.
9. There is not sufficient data collection and analysis to monitor performance and increase productivity.
10. There is a lack of maintenance planning.

Transit Only

The transit companies included in the transit only group are shown in Table 23. These systems ranged in size from 11 to 212 buses, all operating fixed route and schedule service.

Table 23

Transit Only Systems

Systems	No. of Buses
Richmond Transit	212
Tidewater Regional Transit	187
Peninsula Transit	118
Roanoke Transit	41
Lynchburg Transit	27
Charlottesville Transit	26
Petersburg Area Transit	11

Maintenance Facilities

Overall, the maintenance facilities of these properties had more floor space for bus maintenance and were better equipped than those in the municipal fleet group. The facilities were well-maintained, uncluttered, and as clean as can be expected, with the exception of Charlottesville. The size of the work area was adequate in all but the Charlottesville and Petersburg facilities, which were undersized for even the lowest levels of maintenance. As indicated in Table 24, the facilities in all of the systems were reasonably adequate except those in Charlottesville and Petersburg, neither of which had an adequate lift nor automatic washing and cleaning equipment. Charlottesville had no inspection pit of any kind, and Petersburg had no drive-through bay.

Table 24

Maintenance Facilities of Transit Only Systems

	Rich.	Tide.	Pent.	Roan.	Lync.	Char.	Pete.
Drive Thru Bays			X	X	X	X	
Automatic Wash Equipment	X	X	X	X	X		
Automatic Clean Equipment	X	X	X	X			
Vehicle Lifts*	X	X	X	X	X		
Inspection Pits*	X	X	X	X	X		X

*Adequate capacity for transit vehicles now in use or expected to be used in the near future.

Maintenance Equipment

The systems in this group generally were better equipped than the municipal fleets. The types of equipment that are considered essential for properly maintaining transit buses at this level are presented in Table 25. Here again, as in the case of the municipal fleet, the kinds and amounts of equipment depend on the levels of maintenance performed. Petersburg and Charlottesville had much less equipment than the other systems, because of the types of maintenance they engaged in.

The general condition of the maintenance equipment was good. It was well maintained and replaced when necessary. As was the case with the municipal fleets, old equipment, when serviceable, was being used.

Table 25

Transit Only
Required Maintenance Equipment

General:

- Air Compressor
- Chemical Cleaning Tanks
- Parts Wash Vat
- Jib Crane
- Fork Lift Truck
- Oil Pumps, meters and hose
- Grease pump
- Pneumatic wrenches, 1" and 1/2" drive, and socket sets
- Work benches
- Impact chisel and punch
- Torque wrenches
- Assorted vises
- Transmission and engine stands with adapters
- Transmission and engine dollie
- Steam cleaner
- Fire extinguishers
- Battery charger and tester stand
- Assorted drills
- Overhead dispensing units
- Service vehicles

Machine Shop Tools:

- Drill press
- Metal lathe
- Heavy duty press
- Valve facer
- Valve seater
- Valve grinder
- Valve seat grinder
- Band saw

Jacks:

- Portable
- Hydraulic, manual

Chain Hoists:

- Manual
- Power
- Movable

Wheel, Tire and Brake Work:

- Wheel dollie
- Inflation cage
- Brake lathe and grinder
- Tire groover

Body Shop:

- Grinder and buffer
- Electric welder
- Acetylene welder
- Rivet gun (air)
- Paint gun, regulators, filters and hose
- Access to air compressor
- Disc sander
- Sheet metal shear
- Sheet metal break

Test Equipment:

- Injector tester
- Volt meter/multimeter
- Micrometer set
- Air conditioning test equipment
- Compression guage
- Brake decelerometer
- Headlight tester
- Antifreeze tester

Maintenance Practices

The maintenance practices used by this group of properties are shown in Table 26. The first five practices were being used by all the systems and the last 5 by all except Charlottesville and Petersburg, which did not rebuild components and subassemblies for stock nor do body and chassis structural repairs. This information is supportive of the statement made in the previous section concerning the amount of maintenance equipment these two systems had.

All of the systems used scheduled inspections, but the scheduling and content of the inspections were by no means uniform. Elements of these inspections for each system are presented in Table 27, which includes the types of vehicle for which the inspections are designed. This information was taken from the inspection forms used by the systems. It is interesting to note that the inspection forms used at Richmond, Tidewater and Pentran, Figures 1 through 3, are very similar in content and structure. In fact, the basic form used by Tidewater and Pentran, Figures 2 and 3, is identical, and the practice of each property was to add other items at the appropriate schedule intervals. There is also a great similarity in the forms used at Roanoke and Lynchburg, Figures 4 and 5, with two of the inspection schedules used by each system being identical in most respects, with the exception of the mileage intervals at which the inspections were being performed. These forms were not changed every time an inspection or action was altered and it was observed that other inspections and activities were being performed on a regular basis but not included on the form. Although this practice was noted, the extent to which it was being used is unknown. A copy of the inspection form used by each property is included in Appendix E.

The maintenance activities undertaken by these systems were similar in most areas, with the major variations occurring in the mileage intervals. Charlottesville had the largest variance of the mileage schedule, because it used a single maintenance inspection schedule for four different types of vehicles.

The practice of periodic maintenance was described previously as the scheduled change out of parts and major components not including items generally associated with preventive maintenance such as various fluids and filters. None of the municipal fleets used periodic maintenance and only two of the transit only systems were using it on a major scale. The items included in the periodic maintenance schedule at Richmond and Pentran are presented in Table 28. It is readily seen that the items listed are similar for both systems and that Richmond had the larger program in regard to the number of components changed out.

Table 26

Transit Only Maintenance Practices

Practice	Rich.	Tide.	Pent.	Roan.	Lync.	Char.	Pete.
Scheduled inspections	X	X	X	X	X	X	X
Minor repairs	X	X	X	X	X	X	X
Replacement of parts	X	X	X	X	X	X	X
Replacement of major components	X	X	X	X	X	X	X
Repair of major components	X	X	X	X	X	X	X
Rebuild of major components for stock	X	X	X	X	X		
Replacement of subassemblies	X	X	X	X	X	X	X
Repair of subassemblies	X	X	X	X	X	X	X
Rebuild of subassemblies for stock	X	X	X	X	X		
Body and chassis structural work	X	X	X	X	X		

The repair of major components is another essential practice for the effective maintenance of transit vehicles. The extent to which this practice was being used varies among the properties in the transit only group. The usual components found on a transit bus, along with a review of the repair activities undertaken at each of these systems, are presented in Table 29. When this table is compared with Table 15, it is evident that the areas of repair, such as engine and automatic transmission for example, are much broader in the transit only systems. As was observed for the municipal fleets, the level of repair activity undertaken in the transit only systems was also a function of available equipment and trained manpower with a subjective cost variable factored into the equation.

Table 27

Preventive Maintenance Items and Mileage Schedules
Used by Transit Only Systems

(I) Inspect
(R) Replace

	Rich. FLX GMC	Tide. FLX GMC FLX 870 GMC RTS	Pent. FLX GMC	Roan. FLX FLX 870 GMC	Lync. FLX GMC	Char. GMC M.B. B.B. Wayne	Pete. GMC RT
Chassis Lube	6,000	6,000	6,000	3,000	6,000	2,000	4,50
(R) Eng. Oil	12,000	6,000	6,000	9,000	12,000	4,000	9,00
(R) Oil Filt.	12,000	6,000	6,000	9,000	12,000	4,000	9,00
(I) Oil Press.	6,000	6,000	6,000				
(I) Air Filt.	6,000	6,000	6,000	18,000	12,000	4,000	4,50
(R) Air Filt.	48,000	48,000		27,000	36,000	4,000	6 mo
(R) Fuel Filt.	24,000	24,000	24,000	18,000	12,000	4,000	24,00
(I) Belts, Hoses	6,000	6,000	6,000	9,000	6,000	2,000	4,50
(I) Exh. Sys.	24,000			9,000	6,000	2,000	
(I) Coolant	6,000	6,000	6,000	3,000	6,000	2,000	4,50
(I) Trans. Oil	6,000	6,000	6,000	3,000	6,000	2,000	4,50
(R) Trans. Oil	24,000	36,000	48,000	27,000	36,000	8,000	25,00
(R) Trans. Filt.	12,000	36,000	24,000	18,000	12,000	8,000	25,00
(I) Drive Line				9,000	6,000		4,50
(I) Diff. Oil	6,000	6,000	6,000	3,000	6,000	2,000	4,50
(R) Diff. Oil	60,000	48,000	60,000	27,000	36,000	8,000	50,00
(I) Adj. Brks.	2/wk.	6,000	2 wks.	weekly	M,W,F	2,000	4,50
(I) Brk. Lining	6,000	6,000	6,000	9,000	6,000		4,50
(I) Emg. Brk.	6,000	6,000	6,000	3,000	6,000	2,000	4,50
(I) Air Sys.	6,000	6,000	6,000	3,000	6,000	2,000	4,50
(I) Air Comp.	6,000	6,000	6,000	27,000	36,000		4,50
(I) Tanks, Lines	6,000	6,000	6,000	3,000	6,000	2,000	4,50
(I) Starter	6,000	6,000	6,000	27,000	36,000		
(I) Alt. Output	6,000	6,000	6,000	27,000	36,000		4,50
(I) Batteries	6,000	6,000	6,000	3,000	6,000	2,000	4,50
(I) Lights	6,000	6,000	6,000	3,000	6,000	2,000	4,50
(I) Gages, Instrs.	6,000	6,000	6,000	3,000	6,000	2,000	4,50
(I) Steering	6,000	6,000	6,000	9,000	6,000	2,000	4,50
(I) Suspension	6,000	6,000	6,000	9,000	6,000	2,000	4,50
(I) Whl. Brgs.				27,000	3,600	2,000	
(I) Tires	6,000	6,000	6,000	3,000	6,000	2,000	4,50
(I) Body	6,000	6,000	6,000	3,000	6,000	2,000	4,50
(I) Wpr., Wash.	6,000	6,000	6,000	3,000	6,000	2,000	4,50
(I) Ht., Def.	6,000	6,000	6,000	3,000	6,000	2,000	4,50
(I) Air Cond.	6,000	6,000	6,000	3,000	6,000	2,000	4,50
(I) Door Opr.	6,000	6,000	6,000	3,000	6,000	2,000	4,50
(I) Windows	6,000	6,000	6,000	3,000	6,000	2,000	4,50
(I) Seats	6,000	6,000	6,000	3,000	6,000	2,000	4,50
(I) Horn	6,000	6,000	6,000	3,000	6,000	2,000	4,50
(I) Mirrors	6,000	6,000	6,000	3,000	6,000	2,000	4,50
(R) Water Filt.	12,000	12,000	12,000	27,000	36,000		6 mo
Stm. Cln. Eng.	6,000	6,000	6,000	3,000	6,000	4,000	

M-4 Rev. 8-22-78 COACH INSPECTION Inspection No._____

Coach No._____ Fuel-Mi. Per Gal._____

Date Due_____ Mileage_____ Date Completed_____ Oil- Mi. Per Qt. _____

Description Engine	#	Rep. Made	Adj.	OK	Mech Int.
Overhead Valves Inj. Rack					
Gov. Set: Idle____ Full____					
Accel. Control Linkage					
Eng. Air Intake and Filter					
Eng. Support Mountings					
Radiator, Fan, Shutters					
Air, Oil, Water & Fuel leaks					
All Hose & Belts					
Oil Pressure: Idle____ Full____					
Air Box Pressure	4				
Crankcase Pressure	4				
Exhaust back Pressure	4				
Chassis					
Axle Studs Wheel Lugs					
Tire Rods Drag Link					
Suspensions: Bellows					
Shock Absorb. Sway Bar					
Brake Linings					
Hand Brake Link. Adj.					
Brake App. Valve					
Quick Release Valve					
Transmissions 450 rpm-2140 rpm					
Main Oil Pres.____ ____	3				
Conv. in Pres.____ ____	3				
Conv. out Pres.____ ____	3				
Gov. Set.____ Over-Drv.____					
Adj. Shift Cables					

Description Body	#	Rep. Made	Adj.	OK	Mech. Int.	Unit Changes
Outside Panel Glasses						
Int. Floor-Steps-Panels						Check A/C Oper.
Seats-Stanchions-Doors						Check A/C Altenat
Windshield Wash. Fill-Check						
Windshield Wiper-Blades						
Electrical						
Battery: Water-Cables-Tray						
Starter: Cables						
Voltage Regulator-Setting						
Lights-Interior-Exterior						
Clean GRAD-U-STAT - Drain						
Heaters-Defrost-Pumps						
Switches-Fuses-Buzzers-Horn						
Emergency Warning System						
All Bug Lights Must Operate						
Lubrication						
Change Ergine Oil						Tires
Transmission Oil Level						L.F.
Differential Oil Level						R.F.
Lubricate Chassis						R. Inside
Filters-Oil						R. Outside
Water						L. Inside
Fuel						L. Outside
Air						
Fluid						
Run Engine-Check Leaks						

NOTE: Defective Items Not Repaired-List on back of Card. All readings of RPM and Pressures must be listed. Voltage Regulator reading must be taken and listed. Foreman_____

Figure 1. Richmond preventive maintenance inspection form.

BUS INSPECTION

No.

Bus No. _____ FUEL MILES PER GAL. _____

Date Due _____ Mileage _____ Date Completed _____ OIL MILES PER QT. _____

DESCRIPTION	REP. MADE	ADJ.	OK	MECH. INIT.
ENGINE AND TRANSMISSION				
Overhead Valves, Injector Rack				
Stall Idle Gov.				
Accelerator Control Linkage				
Engine Air Intake and Filters				
Engine Support Mountings				
Radiator, Fan and Shutters				
Air, Oil, Water and Fuel Leaks				
Air Comp. Time to Fill Tanks				
Adj. Clutch Shift Cables				
Pulleys and Belts				
FUEL SYSTEM				
Carb. Pump Filter				
IGNITION SYSTEM				
Distrib. Plugs Timing				
Coil Wiring				
CHASSIS				
Axle Studs Wheel Lugs				
Tie Rods Drag Link				
Suspension: Springs Bellows				
Shock Absorbers Sway Bars				
Brakes—Lining Thickness				
Hand Brake Linkage Adj.				
Quick Release and Application Valve				
TOE ADJUSTMENT				

DESCRIPTION	REP. MADE	ADJ.	OK	MECH. INIT.
BODY				
Outside Panels				
Cracked Glass				
Interior—Floor—Steps—Panels				
Seats - Stanchions				
Doors—Front—Speed				
Rear—Treadles—Speed				
Windshield Wipers— Speed— Blades				
ELECTRICAL				
Battery: Voltage Gravity				
Water—Cables—Grease Cradle				
Generator— Brushes—Commutator				
Starter—Brushes—Commutator				
Solenoid—Cables				
Voltage Regulator—Setting-Cables				
Interior and Exterior Lights				
Horn—Instrument Panel				
Heaters and Defrosters				
Switches—Fuses— Buzzers				
Emergency Warning System				
LUBRICATION				
Change Engine Oil and Filters				
Transmission Oil Level				
Convertor Oil Level				
Differential Oil Level				
Lubricate Chassis				
Run Engine—Check for Leaks				
Engine Oil Pressure: Hot Cold				

CHG. LUBE GREASE

OIL FILTER

UNIT CHANGES

TRANSMISSION FLUID PRESSURES

Hydraulic	
Direct	
Main	
Conv. Out Idle	

RPM _____

TORQ. FLUID & FILTER

FUEL FILTER

VALVE COVER

ENGINE TUNE-UP

TORQUE BODY BOLTS

NOTE: Circle Items Repaired.

Defective Items Not Repaired List on Back of Card.

Foreman's Signature

JCF M-9

Figure 2. Tidewater preventive maintenance inspection form.

BUS INSPECTION

No.

Bus No.

FUEL MILES PER GAL.

Date Due

Mileage

Data Completed

OIL MILES PER QT.

DESCRIPTION	REP. MADE	ADJ.	OK	MECH. INIT.
ENGINE AND TRANSMISSION				
Overhead Valves, Injector Rack				
Stall Idle Gov.				
Accelerator Control Linkage				
Engine Air Intake and Filters				
Engine Support Mountings				
Radiator, Fan and Shutters				
Air, Oil, Water and Fuel Leaks				
Air Comp. Time to Fill Tanks				
Adj. Clutch Shift Cables				
Pulleys and Belts				
FUEL SYSTEM				
Carb. Pump Filter				
IGNITION SYSTEM				
Distrib. Plugs Timing				
Coil Wiring				
CHASSIS				
Axle Studs Wheel Lugs				
Tie Rods Drag Link				
Suspension: Springs Bellows				
Shock Absorbers Sway Bars				
Brakes—Lining Thickness				
Hand Brake Linkage Adj.				
Quick Release and Application Valve				
Air Box Pressure				
Blower Restriction				
Secondary Filter Pressure				
Primary Drain & Clean				
Tighten All Water Hose				
Tighten Heater Hose & Air Duct				

DESCRIPTION	REP. MADE	ADJ.	OK	MECH. INIT.
BODY				
Outside Panels				
Cracked Glass				
Interior—Floor—Steps—Panels				
Seats—Stanchions				
Doors—Front—Speed				
Rear—Treadles—Speed				
Windshield Wipers—Speed—Blades				
ELECTRICAL				
Battery: Voltage Gravity				
Water—Cables—Grease Cradle				
Generator—Brushes—Commutator				
Starter—Brushes—Commutator				
Solenoid—Cables				
Voltage Regulator—Setting-Cables				
Interior and Exterior Lights				
Horn—Instrument Panel				
Heaters and Defrosters				
Switches—Fuses—Buzzers				
Emergency Warning System				
LUBRICATION				
Change Engine Oil and Filters				
Transmission Oil Level				
Convertor Oil Level				
Differential Oil Level				
Lubricate Chassis				
Run Engine—Check for Leaks				
Engine Oil Pressure: Hot Cold				

UNIT CHANGES

NOTE: Circle Items Repaired.

Defective Items Not Repaired List on Back of Card

CHECK WHEEL ALIGNMENT

Foreman's Signature

JCI M9

Figure 3. Pentran preventive maintenance inspection form.

FLX 18,000 MILE INSPECTION

	MECHANIC
1. Change trans. filters	
2. Change fuel filters	
3. Check and clean air filter	
4. Check door controls and lubricate linkage	

27,000 MILE INSPECTION

1. Check starter, regulator and generator	
2. Check wheel bearing adjustments.	
3. Check air compressor output	
4. Check toe in and front wheel balance	
5. Check governor R.P.M.	
6. Change differential oil	
7. Change air cleaner and perry water filter	
8. Change trans. fluid	

LUBRICATE WHEEL STUDS AND INSPECT TREADS AT EACH WHEEL CHANGE

REPACK WHEEL BEARINGS AT EACH BRAKE RELINE

SET TOE IN AND BALANCE FRONT WHEELS WHEN FRONT TIRES ARE CHANGED.

Figure 4. Roanoke preventive maintenance inspection form.

FLXIBLE AND GMC 4523A 12,000 MILE INSPECTION

	MECHANIC
1. Change transmission filters	
2. Change fuel filters	
3. Change engine oil by-pass filter	
4. Check and clean air filter	
5. Check door controls and lubricate linkage	

FLXIBLE AND GMC 4523A 24,000 MILE INSPECTION

1. Check starter, regulator and generator	
2. Check wheel bearing adjustments	
3. Check air compressor output	
4. Check toe-in and front wheel balance	
5. Check governor R. P. M.	
6. Change differential oil	
7. Change air cleaner and perry water filter	
8. Change transmission fluid	

LUBRICATE WHEEL STUDS AND INSPECT TREADS AT EACH WHEEL CHANGE.

REPACK WHEEL BEARINGS AT EACH BRAKE RELINE.

SET TOE-IN AND BALANCE FRONT WHEELS WHEN FRONT TIRES ARE CHANGED.

Figure 5. Lynchburg preventive maintenance inspection form.

Table 28

Periodic Maintenance for Transit Only Systems
(Mileage Basis)

	Richmond	Pentran
Air compressor	150,000	150,000
Air governor	60,000	60,000
Engine blower	150,000	150,000
Engine water pump	72,000	78,000
Engine alternator	150,000	
Voltage regulator	102,000	
Engine starter	72,000	72,000
Radiator	100,000	
Fuel injectors	150,000	150,000
Fuel pump	60,000	60,000
Brake foot valve	96,000	100,000
Brake relay valve	48,000	100,000
Differential	150,000	
Steering	100,000	

It was noted previously that the rebuilding of components and subassemblies was a practice engaged in by few of the municipal fleet systems, and that their approach to this need is usually to purchase these components already rebuilt or have them rebuilt by a contractor. In the transit only system the approach is just the opposite. Much less of the rebuilding work is contracted out, as can be seen in Table 30. The two exceptions to this were Petersburg and Charlottesville, both of which contracted out a majority of their rebuild work. Component machining for heavy engine rebuild such as align boring, crankshaft grinding, and cylinder head resurfacing, and the rebuilding of diesel fuel injectors were contracted out by all of the properties.

The final area of maintenance activity to be discussed for the transit only properties is vehicle servicing. The basic tasks performed during vehicle servicing are listed in Table 31. Unlike the systems in the municipal fleet group, all of these properties, except Petersburg, perform these tasks daily; Petersburg washes the vehicles once a week.

Table 29

In-House Repair of Major Components by Transit Only Systems

	Rich.	Tide.	Pent.	Roan.	Lync.	Char.	Pete.
Air System							
Compressor	X	X	X	X	X	X	X
Valves							
Electrical Equipment							
Alternator/generator	X	X	X	X	X	X	X
Starting motor	X	X	X	X	X	X	X
Radio	X				X		
Engine							
Head, block, and crankshaft machining							
Valve and seat machining	X	X	X	X	X		
Valve seat and guide replacement	X	X	X	X	X		
Cooling system	X	X	X	X	X	X	X
Blower	X	X	X	X	X	X	X
Fuel injectors							
Automatic Transmission							
Major repairs	X	X	X	X	X		
Assembly for rebuild	X	X	X	X	X		
Heating and Air Conditioning							
Compressor	X	X	X	X	X		
Controls	X	X	X	X	X	X	X
Blower motors	X	X	X	X	X	X	X
Marine pumps	X	X	X	X	X	X	X
Plumbing	X	X	X	X	X	X	X
Brakes							
Drums	X	X	X	X	X	X	
Lining	X	X	X	X	X	X	X

Table 30

Work (Rebuild) Contracted by Transit Only Systems

	Rich.	Tide.	Pent.	Roan.	Lync.	Char.	Pete.
Air System							
Compressor	X	X			X	X	X
Valves	X	X			X	X	X
Electrical Equipment							
Alternator generator				X		X	X
Starting motor							
Radio		X	X	X		X	X
Engine							
Head, block, and crankshaft machining	X	X	X	X	X	X	X
Valve and seat machining						X	X
Valve seat and guide replacement						X	X
Water pump							
Blower						X	X
Fuel injectors	X	X	X	X	X	X	X
Assembly for rebuild							X
Automatic transmission							
Major repairs						X	X
Assembly for rebuild						X	X
Heating and Air Conditioning							
Compressor						X	X
Controls							
Blower motor						X	X
Marine pump						X	X

Table 31

Vehicle Servicing by Transit Only Systems

D - Daily
W - Weekly

Task	Rich.	Tide.	Pent.	Roan.	Lync.	Char.	Pete.
Fueled	D	D	D	D	D	D	D
Fluid check	D	D	D	D	D	D	D
Visual check	D	D	D	D	D	D	D
Exterior wash	D	D	D	D	D	D	W
Interior sweep	D	D	D	D	D	D	D

Maintenance Personnel

The maintenance personnel at the transit only systems are classified under many headings. The main classifications include bus cleaners, service personnel, mechanic's helpers, apprentice mechanics, and mechanics in different classes or grades.

Most of the mechanic's helpers, apprentices, and mechanics had been promoted from within. This system ensures that personnel will have some familiarity with the construction and operation of a transit bus. Here again, as was the case for the municipal fleet systems, the majority of maintenance personnel had had no previous formal training, and had received none after they were employed. While it is true that there were properties that used the job classification of apprentice, there were no formal, organized apprentice programs and only one organized training program among the systems in the transit only group. The need for formal maintenance training was unanimously expressed by the maintenance management personnel in this group, but there was little formal action. Outside training was being encouraged and supported but was not very popular with the line employees and was available in only the heavily industrialized geographic areas. The one property that was using a formal training approach was Richmond. The attitude and direction taken by the maintenance personnel at Richmond is apparent when you review the content of the introductory page of the informational training guide being used there and reproduced here in Figure 6.

The turnover of maintenance personnel was relatively low in these systems. This may be explained by the wage rates in the larger population areas such as Richmond, but is more probably explained by the better than average benefits and perceived job security associated with public employment. The overall wage rates at the transit only systems were higher than those found in the municipal fleets and ranged from $3.75 for cleaners to $9.37 for top-level mechanics. Five of the transit only systems used organized labor; only Charlottesville and Petersburg used nonunion workers. The difference in wage rates did not appear to be related to the union status of labor but rather to the geographic location and size of the system.

MECHANICAL DEPARTMENT

INSTRUCTOR'S GUIDE

The purpose of the Job Training Program is to acquaint Mechanical personnel with the correct methods and procedures in the performance of preventive maintenance.

The preventive maintenance program is the backbone of all fleet operations and must be carried out systematically to insure a high degree of effeciency. Preventive maintenance actually means a way of eliminating the causes of breakdowns before they occur. A good preventive maintenance man is a real "pro" and is continually looking for "trouble" that might occur and to "nip it in the bud" before it happens.

As in any "in house" training program our goal is to help the employee obtain a better working knowledge of the job performance that is expected. By providing the employee a means by which to improve his working knowledge, not only does the employee gain personal benefits, the company in turn receives benefits that are technically measured in the costs column.

There is something to be learned daily!!

Weekly: Wednesday - Thursday - Firday -
8:00 A.M. - 11:00 A.M.
9 hour course

Training and refresher courses are for all personnel involved in the Mechanical Maintenance, Repair, and Inspection of revenue equipment. Sessions run for approximately three (3) hours duration and will cover a variety of subjects. Sessions will incorporate films and actual "touch and feel".

Notes are to be taken by trainees.

Booklets are to be issued for each training session.

Figure 6. Introduction to Richmond training manual.

Maintenance Organization

These seven properties use three approaches in organizing maintenance. These approaches can be identified with three subsets of systems for the groups as shown in Table 32. As seen in this table, Approach 1 was being used in the subset containing Richmond, Tidewater, and Pentran. In these properties, preventive maintenance inspections, running repairs, and unit rebuilds were being carried on by separate groups of maintenance employees. For example, a mechanic performing a unit rebuild would not install the unit as a running repair, nor would the inspection mechanic remove and rebuild a major component. However, it was common to find these types of mechanics offering advice and assistance to each other in troubleshooting and diagnosis. In addition, certain mechanical systems were diagnosed and repaired only by those individuals highly skilled in particular tasks. This approach may be taken for electrical components, air conditioning, engine, and transmission. Usually, mechanics were formally designated for troubleshooting and repair for only electrical components and air conditioning. It was observed that the maintenance foreman played an important role in this regard. The foreman, by virtue of his knowledge of the level of skill each mechanic had, could informally organize maintenance functions so that the skill level would match the needed repairs.

Table 32

Organization of Maintenance Functions by Transit Only Systems
(Work Assignments by Function)

	APPROACH 1			APPROACH 2		APPROACH 3	
	Rich.	Tide.	Pent.	Roan.	Lync.	Char.	Pete.
Preventive maintenance inspections	X	X	X				
Running repairs	X	X	X				
Unit rebuild	X	X	X	X	X		
Mechanics who are area specialists	X	X	X				N/A
Informal organization by maintenance foreman	X	X	X	X	X	X	X	N/A

Approach 2 was being used in the systems in the second subset; namely Roanoke and Lynchburg. In these two systems, only the unit rebuild function had a designated staff. Preventive maintenance and running repairs were performed by all the mechanics. In addition, at Roanoke it was observed that the mechanics were also responsible for the daily cleanup of the buses, as there were no service personnel to wash and sweep out the buses.

Approach 3 was being used in Petersburg and Charlottesville, the systems in the third subset. No maintenance personnel were designated by function in these properties and the work was assigned as it became necessary.

The systems in the transit only group did not usually prioritize their maintenance activities, with the exception of Charlottesville and Petersburg, both of which attended to breakdown maintenance and running repairs on a priority basis, but did not assign priorities by kind of vehicle, as only transit vehicles were being maintained.

Vehicle Maintenance Management Information System (VMMIS)

In the transit only properties VMMIS is given much more attention than in the municipal fleets. The types of maintenance information forms used in these systems are presented in Table 33. Information is collected in a more organized manner and is used to track the performance of the transit vehicles. Richmond was the only system using a computerized approach; however, Pentran and Tidewater were studying computer applications. The data collected are presented in Table 34. Although not readily apparent from this table, the collection and analysis efforts at Charlottesville and Petersburg were much smaller than those at the other five properties. A sample of the output material produced can be seen in Figures 7 through 10. This material represents a step toward commitment to quality control and performance monitoring that is necessary to retain present productivity and initiate future increases. Copies of the various maintenance forms used by all these properties are given in Appendix F.

Even though an attempt was being made to monitor performance, it was observed that, with the exception of Richmond, none of these systems had any written goals and objectives pertaining to the maintenance operations. In addition, Richmond was the only system with expressed performance levels and indicators, such as 4,500 miles per road call and productive man-hours per 1,000 bus miles, being used to measure maintenance performance.

Table 33

Maintenance Information Forms for Transit Only Systems

	Rich.	Tide.	Pent.	Roan.	Lync.	Char.	Pete.
Operator defect or inspection sheet	X	X	X	X	X	X	X
Daily fuel, oil and fluid use record	X	X	X	X	X	X	X
Preventive maintenance inspection sheet	X	X	X	X	X	X	X
Road call record	X	X	X	X	X		X
Repair order	X	X	X	X	X	X	X

Table 34

Maintenance Data Recorded by Transit Only Systems

	Rich.	Tide.	Pent.	Roan.	Lync.	Char.	Pete.
Labor	X	X	X	X	X	X	X
Parts	X	X	X	X	X	X	X
Repair	X	X	X	X	X	X	X
Mileage	X	X	X	X	X	X	X
Oil Use	X	X	X	X	X	X	X
Fuel Use	X	X	X	X	X	X	X
Roadcalls	X	X	X	X	X		X
Missed runs due to maintenance							
Late runs due to maintenance	X						
Component failures	X		X				
Subassembly failures	X		X				
Buses down for maintenance	X	X	X	X	X	X	

GREATER ROANOKE TRANSIT COMPANY

ROAD CALL FAILURE RECORD for month of _____ 19 ____

	TYPE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
MECHANICAL	Air System																																
	Brakes																																
	Cooling System																																
	Doors																																
	Electrical																																
	Engine																																
	Fuel																																
	Steering																																
	Transmission																																
	Clutch																																
	Body																																
	Chassis																																
	Heating System/AC																																
NON-MECHANICAL	Nothing Found																																
	Accidents																																
	Fare Boxes																																
	Tires																																
	Dirty Bus																																
	Transportation																																
	TOTALS																																

TOTAL MILES OPERATED _____ LESS NON-MECHANICAL _____

MILES PER ROAD CALL: MECHANICAL _____ MECH. ROAD CALLS _____

NON-MECH _____

TOTAL _____

Figure 7. Monthly road call record for Roanoke.

MONTHLY REPORT OF WORK THROUGH SHOP

SHOP_____ MONTH OF_____ 19___ DATE_____ 19____

DESCRIPTION	MONTH	YR TO DATE	DESCRIPTION	MONTH	YR TO DATE
AIR CONDITION			TRANSMISSIONS		
A.C. ALTERNATOR			TURBINES		
A.C. CLUTCH HSG.			DIFFERENTIAL		
HYD. MOTOR/PUMP			CLUTCH ASSYS.		
A.C. COMPRESSOR			ENGINE BLOWERS		
A.C. CLUTCH CYL.			FLUID PUMPS		
			STEERING BOXES		
			HYD. GOVERNOR		
ELECTRICAL			FLUID COOLER		
ALTER. & GEN.			VALVE BODIES		
STARTERS			RADIATORS		
REGULATORS			WATER PUMPS		
BALLAST			FUEL PUMPS		
WIRE HARNESS			FLEX ASSYS.		
BLOWER MOTORS			SLACK ADJUSTERS		
BOOSTER PUMPS			THERMOSTATS		
AIR-ELE. SHIFT					
RELAYS					
FLASHERS			ENGINE OVH.		
SPEED-O-METERS			ENG. BLOWER DRV. COUP.		
AIR			CYLINDER HEADS		
AIR COMPRESSORS			FAN DRIVES		
			OIL PUMPS		
BRAKE APP. VALVE			CAM SHAFT BRG.		
BRK. RELAY VALVE					
BELLOWS ASSY.			6000-MILE INSP.		
GRAD-U-STATS			BRAKES RELINED		
LEVEL VALVE			ACCIDENTS		
MOISTURE EJE. VALVE			BUSES PAINTED		
ACCEL. VALVES					
WIPER MOTORS					
DOOR ENGINES					
BRAKE CHAMBERS					
MOD. VALVE					

REV. 2-12-76

Figure 8. Maintenance activity record for Pentran.

GREATER LYNCHBURG TRANSIT CO.
Coach Road Call Summary

ROAD CALL CAUSE	Type of Coach			Total For Mo.	Total Last Yr.
	TDH 3301 (1969)	Flxible (1975)	T6H4534A (1976)		
1. Air Equipment					
2. Belts					
3. Brakes					
4. Body Parts					
5. Clutch					
6. Cooling					
7. Engine					
8. Electrical System					
9. Ignition					
10. Fuel System					
11. Heaters/Defrosters					
12. Misc. Drive Parts					
13. Rear Axles					
14. Springs/Suspension					
15. Steering-Front Axle					
16. Transmission					
17. Tires					
18. Out of Fuel					
19. Air Conditioning					
TOTAL CALLS CHARGED TO EQUIPMENT					
AVERAGE MILES PER CALL CHARGED TO EQUIPMENT.					
20. Farebox					
21 Accident					
22 Unclassified					
TOTAL CALLS NOT CHARGED TO EQUIP.					
AVERAGE MILES PER CALL NOT CHARGED TO EQUIPMENT					
TOTAL ALL CALLS					
AVERAGE MILES PER TOTAL CALLS					
TOTAL BUS MILES					

Figure 9. Road call summary for Lynchburg.

GRTC FLEET PERFORMANCE REPORT

Month of _____

Bus	Description	Miles This Month	Cumulative Miles	Gals. Fuel	M.P.G. Fuel	Qts. Oil Used	Miles Qt. Oil Added
161							
162							
163							
164							
165							
166							
167							
168							
169							
170							
171							
172							
173							
174							
175							
176							
177							
178							
179							
180							
181							
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190							
191							
192							
193							
194							
195							

Figure 10. Fleet performance for Roanoke.

Maintenance Planning

The original basis for all maintenance planning in the transit only group was the manufacturer's recommendation and operating experience. In addition, all of the properties used fuel and oil use as an indication of possible maintenance problems. As indicated in Table 35, these properties, with the exception of Petersburg and Charlottesville, had added data analysis in order to profile the vehicle maintenance history. Richmond and Pentran had continued further with the use of periodic maintenance based originally on experience and subjective opinion. Efforts were under way to modify the periodic maintenance schedule according to data collected on component failures. Richmond had computerized its operation and Pentran was considering such an approach.

During the site visits it was observed that the planning actions being taken did not include the entire maintenance operation in any of these systems. However, Richmond, Tidewater, and Pentran were moving to total system planning. As in the case of the municipal fleets, the kind of data being collected from the various maintenance areas and the general lack of computer analysis were prime causes of the slow implementation of system - wide maintenance planning. In spite of the fact that maintenance planning was much further advanced and more progressive in the transit only group than in the municipal fleetgroup, relatively unsystematic methods that must rely on subjective judgements and trial and error were being used to make up for the lack of data collected previously and the basic conservative nature of transit management that has existed.

Table 35

Maintenance Planning Activity for Transit Only Systems

	Rich.	Tide.	Pent.	Roan.	Lync.	Char.	Pete.
Goals and objectives	X						
Manufacturers' recommendations	X	X	X	X	X	X	X
Operating experience	X	X	X	X	X	X	X
Data collection	X	X	X	X	X	X	X
Accessible data	X	X	X	X	X	X	X
Data analysis	X	X	X	X	X		
Vehicle profiles	X	X	X	X	X		
Component failure trends	X		X				
Subassembly failure trends	X		X				
Performance indications and measures	X	X					

It should be pointed out here that during this discussion it was quite common for Charlottesville and Petersburg to be excluded or otherwise set apart from the other transit only systems. This is not an attempt to characterize their maintenance operation as being inferior or unproductive. The maintenance operation at both systems was being carried on under extremely adverse conditions. Petersburg owned no maintenance facility and rented a small portion of the Tri-Cities maintenance facility, which consisted of one pit and a storage area. This situation was soon to be eliminated as a new maintenance facility was being constructed and equipped. Charlottesville, although already located in a relatively new maintenance facility, had had the number of buses double in a year without the attendant necessary improvements to the maintenance operation. Improvements to the Charlottesville facility and method of operation were being formulated by the newly appointed maintenance supervisor and system manager.

Summary

The general findings and information gathered during site visits to the transit only systems are the basis for the descriptive list presented below. Not all of these characteristics are applicable to each of the transit only operations; however, all are negative factors that diminish maintenance productivity.

1. The maintenance employees were in need of initial or additional training.

2. There was a general lack of goals and objectives in the maintenance area.

3. There was a general lack of locally developed and implemented performance indicators for maintenance.

4. There was insufficient data collection and analysis for monitoring the performance of maintenance and increasing productivity.

5. There was insufficient maintenance planning.

FACTORS AFFECTING MAINTENANCE PERFORMANCE

The questionnaire results, when combined with the observations and information obtained during the site visits, provided

a data base that was analyzed to identify and classify factors which affect the productivity of transit bus maintenance. The major factors uncovered are presented in Table 36. Table 37 presents a matrix showing the interaction of these factors. When the matrix is reviewed it is clearly evident that there is a fair amount of interaction among all factors. However, in this study, not all the operating properties were affected by each of these factors as is indicated by the information presented in Table 38. In addition, these factors affected different systems to varying degrees. The factors are discussed under the following subheadings.

Table 36

Factors Affecting Maintenance

Lack of goals and objectives

Inadequate maintenance personnel assignments

Inability to hire qualified personnel

Need for maintenance personnel training

Low maintenance priority for transit vehicles

Inadequate facility capability

High incidence of running repairs

Need for data collection and analysis

Need for maintenance system planning

Need for periodic maintenance programs

Inadequate preventive maintenance programs

Need to educate local political bodies

Present condition of the buses

Use of inadequate buses

Use of obsolete buses

Complex design of the advanced design bus (ADB)

Skill level needed to maintain ADB

Need for transit vehicle expertise

Inadequate number of spare buses

Table 37

Maintenance Factor Interaction Matrix

	GOALS AND OBJECTIVES	PERSONNEL ASSIGNMENTS	QUALIFIED PERSONNEL	PERSONNEL TRAINING	MAINTENANCE PRIORITY	FACILITY CAPABILITY	RUNNING REPAIRS	COLLECT, ANALYZE DATA	MAINTENANCE PLANNING	PERIODIC MAINTENANCE	INADEQ. PREVENT. MAINT.	LOCAL POLITICAL BODIES	CONDITION OF BUSES	INADEQUATE BUSES	OBSOLETE BUSES	DESIGN OF THE ADB	MAINTAIN ADB	VEHICLE EXPERTISE	INADEQUATE SPARES
GOALS AND OBJECTIVES		X		X	X	X	X	X	X	X	X	X	X	X				X	X
PERSONNEL ASSIGNMENTS	X		X	X	X		X			X	X	X	X					X	
QUALIFIED PERSONNEL		X		X			X		X	X	X		X				X		
PERSONNEL TRAINING	X	X	X				X		X	X	X	X	X				X	X	
MAINTENANCE PRIORITY	X	X					X		X	X	X	X	X					X	
FACILITY CAPABILITY	X						X				X	X	X					X	
RUNNING REPAIRS	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X
COLLECT, ANALYZE DATA	X						X		X	X	X	X	X					X	
MAINTENANCE PLANNING	X		X	X	X		X	X		X	X	X	X					X	X
PERIODIC MAINTENANCE	X	X	X	X	X		X	X	X		X	X	X					X	X
INADEQ. PREVENT. MAINT.	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X
LOCAL POLITICAL BODIES	X	X		X	X	X	X	X	X	X	X		X	X				X	X
CONDITION OF BUSES	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
INADEQUATE BUSES	X						X				X	X	X					X	
OBSOLETE BUSES							X				X		X						
DESIGN OF THE ADB							X				X		X				X		X
MAINTAIN ADB			X	X			X				X		X			X			
VEHICLE EXPERTISE	X	X		X	X	X	X	X	X	X	X	X	X	X					X
INADEQUATE SPARES	X						X		X	X	X	X	X			X		X	

Table 38

Maintenance Factor Effect by System

	Rich.	Tide.	Pent.	Roan.	Lync.	Char.	Pete.	Danv.	Bris.	Stau.	Winc.	Jacc.	Harr.
GOALS AND OBJECTIVES		X	X	X	X	X	X	X	X	X	X	X	X
PERSONNEL ASSIGNMENTS								X			X	X	X
QUALIFIED PERSONNEL	X	X	X	X	X	X	X	X	X	X	X	X	X
PERSONNEL TRAINING	X	X	X	X	X	X	X	X	X	X	X	X	X
MAINTENANCE PRIORITY								X			X	X	X
FACILITY CAPABILITY						X	X	X			X		X
RUNNING REPAIRS		X		X		X	X	X	X			X	
COLLECT, ANALYZE DATA		X	X	X	X	X	X	X	X	X	X	X	X
MAINTENANCE PLANNING	X	X	X	X	X	X	X	X	X	X	X	X	X
PERIODIC MAINTENANCE		X		X	X	X	X	X	X	X	X	X	X
INADEQ. PREVENT. MAINT.	X	X	X	X	X	X	X	X	X	X	X	X	X
LOCAL POLITICAL BODIES	X	X	X	X	X	X	X	X	X	X	X	X	X
CONDITION OF BUSES		X		X		X	X	X	X			X	
INADEQUATE BUSES						X					X	X	X
OBSOLETE BUSES						X		X	X	X		X	
DESIGN OF THE ADB		X		X			X						
MAINTAIN ADB		X		X			X						
TRANSIT VEHICLE EXPERTISE						X	X	X	X	X	X	X	X
INADEQUATE SPARES		X	X	X							X	X	

Goals and Objectives

The lack of goals and objectives specifically pertaining to vehicle maintenance operations precludes the targeting of improvements that maintenance operations may strive to attain.

The formulation of goals would provide overall direction for the maintenance function while the generation of objectives, using local operating conditions and characteristics as inputs, would ensure a structured means of addressing the other factors identified as affecting the performance of maintenance. Included in this group of objectives should be the development of performance indicators and measures for evaluating the results of any actions taken.

The use of performance indicators or measures is most readily accepted in planning and funding. They can be used to establish an effective and easily documented approach to obtaining the funding necessary for a particular level of maintenance activity. In turn, operating at or above the level of the indicators can be a convincing argument when asking local agencies to award funding on a priority basis.

The other purpose for using performance indicators is to assist management in planning and internal control. The possible benefits to maintenance of a group of indicators such as those in Table 39 is clearly evident. The use of oil and fuel on a mileage basis, hours of operation per mechanic, and miles per road call all provide an indication of the performance of the maintenance operation.

The development of indicators and measures must be done on the local level. Vehicle maintenance is extremely site-specific and varies widely with local operating conditions and characteristics. While the indicators must be formulated on the local level, there are some broad criteria, such as those listed in Table 40,[14] which may be helpful.

It is recognized that many systems may need assistance of some kind in formulating goals and objectives and then, in turn, a set of maintenance performance indicators, but this action is vital to a systematic approach to maintenance. In addition, properties will most likely use their maintenance staff to formulate the goals, objectives, and indicators. Where this is done, the outcome has a high probability for success, because these individuals operate the system on a day-to-day basis and can greatly influence the acceptance and proper use of the indicators.

Table 39

Common Performance Indicators

Annual miles per bus

Annual hours per bus

Spare bus ratio

Bus miles per quart of oil

Bus miles per gallon of fuel

Bus miles per maintenance caused road call

Maintenance hours per bus

Annual operation hours per maintenance hour

Percentage of fleet available for service

Table 40

Criteria for Selection of Performance Indicators

1. Related to a stated system objective.
2. Easily understandable and definable.
3. Unbiased and objective.
4. Measurable from available data.
5. Methodologically correct (i.e., property separating input and output measures).
6. Acceptable to the parties involved.

Source: Reference 14.

There are many areas in which objectives can improve transit vehicle maintenance. An objective that calls for a performance indicator of some kind would in turn reflect any lack of the data collection and analysis needed for the use of that indicator. The implementation of an objective that specifies a certain level of preventive maintenance would highlight an inadequate number of spare buses on hand to allow the preventive maintenance program to be implemented fully. The adoption of an objective dealing with the education of local political bodies may in turn provide relief from inadequate maintenance personnel assignments. These are only three out of many possible areas in which objectives may have a positive affect.

Inadequate Maintenance Personnel Assignments

A transit bus is not simply a large automobile or a truck in some unusual shape. It is constructed in a unique manner and for a specific purpose. Consequently, the various subsystems assembled to produce a transit bus are highly technical and complex. The result is that the complete system — a bus — is technically complex, and proper maintenance of this system requires considerable technical skill. An automobile or truck mechanic, even an excellent one, is not a transit bus mechanic. It follows, therefore, that the maintenance of transit buses should be delegated to transit bus mechanics. Since it is very difficult to hire experienced transit bus mechanics, the next best approach is to designate persons who show an interest in maintaining transit buses as transit bus mechanics on a permanent basis, and to secure for these employees as much transit bus maintenance training as possible before assignment and during their entire tenure. The practice now used by some systems of assigning transit bus maintenance to any and all of the general shop mechanics should be avoided.

Qualified Personnel and Training

As mentioned previously, it is difficult if not impossible to hire a qualified transit bus mechanic. There is not a large pool of persons who have the needed qualifications. The formal training necessary to produce a transit bus mechanic is unavailable except to employees of relatively large operating systems. Once a bus mechanic has received the training and experience available at a large operating system, with its corresponding level of monetary compensation, it is unlikely that he will leave and accept a position of comparable responsibility for less pay in a small or medium-sized system. In addition, the national trend toward decreased vocational education makes even the prospect of obtaining suitable raw material for transformation into transit bus mechanics an increasing uncertainty. The direct outcome is then both obvious and the worst one possible. Demand for qualified personnel is increasing while the supply is decreasing.

It is not usually possible for small and medium-sized systems to engage in formal training exercises for various reasons, not the least of which is cost. For this reason, the approach generally taken is to allow the mechanic to learn on the job. This is a viable approach if it is under the umbrella of an organized apprentice program that has qualified master mechanics serving as tutors. However, the usual procedure is one of trial and error,

with the cost of the errors being absorbed by the system. This is a very expensive approach and often prevents a transit bus mechanic from ever obtaining the diagnostic skills necessary for precise vehicle repair. One obvious solution is for each system to engage in routine training and conduct a viable apprentice program, but the majority of small systems do not have the resources necessary to do so. Another solution would be to develop one training facility for all the systems. This appears to be a much more logical approach when considered in terms of cost, availability of manpower, and duplication of effort. There are any number of approaches that could be taken, and the following three are presented as examples.

A state organized and administered training program could be operated in a central geographic location and offer short courses covering all aspects of transit bus maintenance. Another approach would be to have one of the larger properties serve as the training facility, with the operation being supported by a block grant to an organization of the transit properties such as the Virginia Association of Public Transit Officials (VAPTO), which would be responsible for the direction and administration of the programs. A third scheme would be for the Public Transit Division to underwrite the cost of training to be provided by one of the larger properties. The content and organization of the training in this case would be developed by a cooperative effort among all the operating systems.

Maintenance Priority

The maintenance of various kinds of municipal equipment on a priority basis ahead of or instead of transit bus maintenance is certainly counterproductive. Transit vehicles generate revenue which is used or can be used to cover a portion of their operating cost. The ability to generate this revenue is directly dependent on the reliability of the transit bus in revenue service, and the reliability of the transit bus in service is a function of the type and amount of maintenance performed, the ability to reschedule routes, and the number of spare buses in the fleet. The proper maintenance of the bus is the most cost-effective method of ensuring system reliability as opposed to having a large percentage of the fleet as spares and the difficult process of rescheduling to meet published route times. Neglecting or deferring preventive maintenance adds to late runs and in-service breakdowns, both of which affect the demand for service.

A refuse truck that does not make an appointed schedule will not cause a loss of revenue; an unreliable transit bus will. Transit buses must meet published schedules in order to generate revenues, and a low maintenance priority seriously impairs this process.

Assigning a low maintenance priority to transit vehicles strengthens the observation that, in most cases, transit bus maintenance is considered a stepchild that can be easily taken in by a municipal fleet operation. The same type of argument presented in the discussion of personnel assignments is also applicable here. A transit bus cannot be maintained in the same manner as an automobile or truck. Transit bus parts, with the exception of common diesel engine parts, filters, etc., are difficult to obtain at the local level. Transit buses cannot be maintained on an ad hoc basis with measurable success in terms of vehicle reliability. Add to this the immediacy of repairs often required in order to meet scheduled runs and it becomes apparent that a well-organized and planned transit bus maintenance program can support the maintenance of other types of vehicles much more effectively than the mixed fleet maintenance program can support transit bus maintenance on an adjunct basis.

Facility Capacity and Equipment

For the systems studied, the main reason for facilities being undersized and ill-equipped was age. In the case of the municipal fleet systems the facilities were constructed before any transit bus operations were undertaken. The only alternatives in most of these cases were to remodel or to construct entirely new facilities capable of handling transit buses, or to continue in the present structures realizing the loss to productivity and adjusting as well as possible. Capacity was not a major concern in the transit only systems except for Charlottesville and Petersburg. In Petersburg, a new maintenance facility was being built, and Charlottesville was aware of the need for considerable improvement to the maintenance facility and equipment.

Running Repairs and Road Calls

Running repairs and road calls were attributed to several causes. In the municipal fleets, the equipment often had high mileage or was purchased used. The maintenance of this equipment had in some cases been deferred by the original owners or been carried out in a haphazard manner. Some light- and medium-duty equipment was being used for heavy-duty applications with the result being increased failures and deterioration. Several of the municipal fleets were operating models of equipment no longer being manufactured and proper parts were difficult to obtain. Last but not least of the causes were the reoccurring repairs in the same system or component resulting from insufficient diagnosis of the problem or incomplete attention to repairs. The level of

running repairs was a serious obstacle to adequate preventive maintenance; there was a lack of maintenance personnel to carry out both tasks. Breakdown maintenance must take priority since the buses must meet the schedules, and this causes further deterioration of the vehicles.

Several of the transit only properties had the same problem for reasons already described. Other transit only properties had high running repairs and roadcalls resulting from the operation of advanced design buses that were requiring an inordinately high level of maintenance.

A high level of effort on running repairs and roadcalls reduces the ability of a system to implement systematic maintenance planning.

Data Collection and Analysis

The data necessary for effectively managing a vehicle maintenance system were usually being recorded by someone in the organization, but often were not compiled in any organized fashion. The unlinked recording of data may meet specific requirements for various actions allied to or included under the maintenance functions; however, it does not provide the needed performance picture with which to assess the actions being taken by an operation. In addition to being collected, data used for monitoring performance must be analyzed. The total number of road calls or maintenance labor hours can be used to evaluate overall system performance, but analyzing the data will provide insight into why the performance has decreased or increased and what further actions, if any, should be taken.

The lack of data collection and analysis is another of the factors related to the absence of periodic maintenance and systematic maintenance planning. In the past, the Urban Mass Transportation Administration has funded research to develop data collection and analysis systems for use by large operations. What is needed now is an approach that will address this deficiency so prevalent in the small and medium-sized operations. This approach could be illustrated through a research and demonstration program using a computer-based VMMIS at a small transit property.

This demonstration program should be particularly concerned with the collection and input of data reflecting local operating characteristics and conditions to formulate performance indicators and measures. In addition, it must consider the ease of system operation and understanding along with detailed cost information concerning the operation of the system to provide a comparison of the costs of the demonstration system with those of the existing

system of manual data collection and analysis. It is also important that the system address disaggregate vehicle maintenance costs, which are essential for a comprehensive review of the current preventive maintenance program and any newly developed program that would include the addition of periodic maintenance.

Maintenance Planning

A discussion of what maintenance planning should include has been presented. The implementation of meaningful maintenance planning is impossible without the support of adequate data collection and analysis at the individual property level. The practice of vehicle maintenance is site-specific and so must be the planning of the maintenance. Local conditions, in addition to the vehicle-related information that is collected, must be monitored and used as an input to planning. Data from both of these sources must be reviewed and analyzed, which is a considerable task. Small systems generally do not have the expertise or the number of people necessary for these functions. The solution, then, lies in using computer assistance.

The usual organizational and institutional contentions used to defend the status quo were very much in evidence in this study. Systematic maintenance planning was not understood very well by the usual operational personnel, so it was opposed. These personnel did not know how this type of maintenance planning would turn out, and no one was willing to risk the blame for a negative outcome. Typically, there was apprehension over who the new method would affect and what it would cost. This is consistent with the general conservative approach often found in transit management.

The approach to systematic maintenance planning now being used by progressive transit properties requires complex computer programs and a relatively large and expensive amount of computer support. This is fine for large systems such as the Chicago Transit Authority, but does not seem feasible for the small operating properties found in Virginia. The direction taken must be the same, but the level of data collection and analysis must be tailored to the size of the operation to balance costs and benefits. The use of basic statistics and simple forecasting methods in conjunction with affordable minicomputer hardware and software would seem appropriate for small systems. The planning of component change out schedules and maintenance inspection intervals can be generated from the data analysis. An example of this type of output used in Richmond is shown in Figure 11. The printout indicates

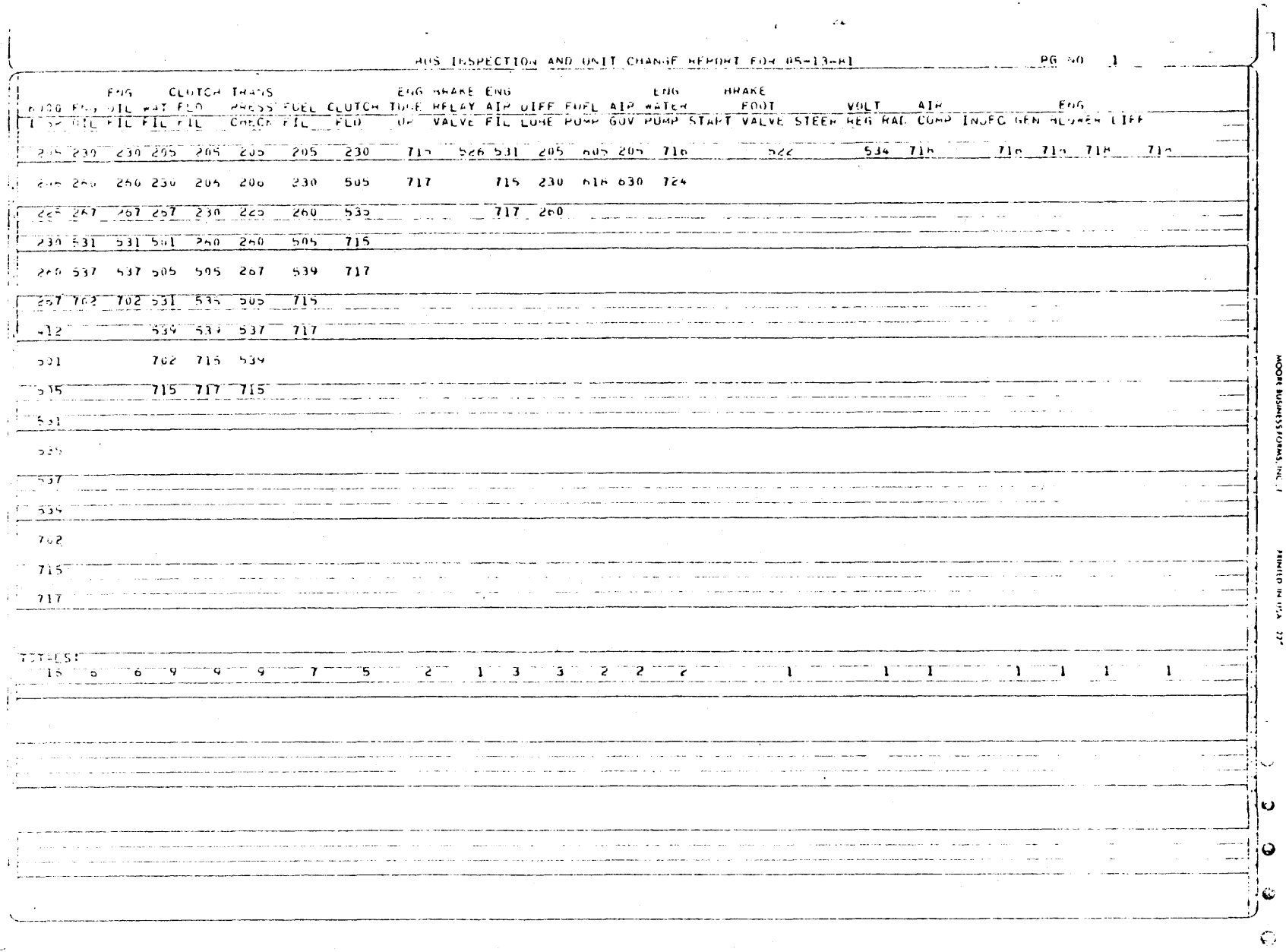

Figure 11. Richmond printout.

the maintenance inspections and component change outs that need to be performed and the buses that need to be scheduled. The data analysis should be done on a continuing basis such that all new data are considered on the basis of the current situation and the component and vehicle historical profile. This will result in a maintenance plan that will update itself as the vehicle characteristics, components and subassemblies, and operating conditions change over time.

The type of maintenance planning found in Virginia was not really planning but rather the use of a historical perspective to attack a present and very probable future problem. For this reason, maintenance system planning is now a necessity and will escalate in importance with increasing demands and decreasing resources in the transit industry.

Periodic Maintenance

The lack of periodic maintenance found was very similar to that of maintenance planning. Goals and objectives, along with data collection and analysis, were major influences on the limited use of this procedure. Running repairs, personnel assignment, qualified personnel, priority maintenance, local political bodies, and inadequate preventive maintenance, all of which are interrelated factors themselves, were directly connected to the lack of periodic maintenance.

Inadequate Preventive Maintenance

This heading describes the current situation in transit bus maintenance. It is influenced by or influences all the other factors presented in Table 36. The designation "inadequate" should not be construed as "bad". The maintenance being practiced for the most part was good, but will be slow to increase in volume, if it increases at all, unless the identified factors are addressed in a proper manner. The maintenance programs were, as a whole, producing credible results considering the level and type of external influence they were operating under.

Political Body Understanding

This factor is perhaps the most important and surely the most interesting one identified. In general, the commitment of the local political bodies to support transit operations was strong. The commitment, however, was usually thought of in terms of schedules, routes, and people served and not in terms of operational feasibility and support. As a matter of policy, they were found to control the service and make the transit operation responsible for the support. This approach can and did have a negative impact on system reliability.

It is important to understand that the members of a local political body are not expected by their constituents or anyone else to be experts in the daily operation of a transit system. The transit manager or supervisor is employed for this reason. It is just as important to realize that policy and budget decisions made by local political bodies have a great effect on the transit system. If the members of these groups had a better understanding of the operating realities and current conditions, they could make better informed decisions. Very often it is hard for a person with no technical background to grasp the complexities of what may appear to be a straightforward undertaking such as properly maintaining a transit bus. Management of public transit must increase its educational effort and undertake programs aimed at informing and educating local public officials. This approach must also be taken with state and federal officials who have influence or control over matters pertaining to public transit. Education is a two-way process. Public transit officials must begin to increase their interest in transit and communicate with the operations personnel as well as transit management in an attempt to improve their understanding of the present situation.

Condition of Buses

Directly or indirectly, all of the identified factors are related to the condition of transit vehicles. Factors such as inadequate preventive maintenance, personnel assignments, maintenance priority, and lack of planning are clearly examples of this.

The present condition of much of the rolling stock can be attributed to deferred maintenance or the lack of an adequate preventive maintenance program.

Four of the reviewed properties in Virginia — Danville, Bristol, James City County, and Charlottesville — were operating fleets of transit buses containing a majority of vehicles in a condition that required a much greater maintenance effort than would usually be expected.

The situation at Danville could be attributed to the used buses they had purchased having accumulated high mileage with much of the preventive maintenance having been deferred by the original owners. The average age of the transit buses being operated at Danville was very high, 17 years, and the mileage, although it could not be determined accurately because of the mechanical condition and the lack of original records, was very high. Also, the fleet at Danville included obsolete equipment, which will be discussed in the next section.

The buses in the Bristol fleet had an average age of 12 years and very high accumulated mileage. These buses were purchased new and their condition was due to age, mileage, and lack of an organized preventive maintenance program for the last several years. This fleet also contained obsolete vehicles.

The condition of the vehicles used by James City County reflected a lack of control over the maintenance function, which until recently had been completely contracted. The mechanics were unfamiliar with the foreign-made vehicles in the fleet and difficulties were being experienced in obtaining parts at a reasonable price and in an acceptable length of time. The result of these factors was that the maintenance being performed was not always what was needed when it was needed. This situation was exacerbated by the fact that the vehicles were no longer being marketed in the United States and were inadequate, as will be discussed later.

The condition of the fleet in Charlottesville reflected all the factors already discussed plus several others. Until recently, their maintenance program had to cover only 12 buses. Unfortunately, 8 of those were of the foreign type already discussed in the case of James City County and the other 4 were the first of their kind to be manufactured by a domestic firm. Compounding the difficulty was the absence of any organized maintenance. Consequently, this fleet suffered mechanical deterioration at a rate much faster than would be expected under normal circumstances.

The decision was then made to expand the transit service in Charlottesville and, in order to effect this increase, it was necessary to obtain additional vehicles. Given the short lead time, it was necessary to lease 11 vehicles until new buses could be purchased. The buses that were leased had already been retired from service by a larger transit property in Virginia and were old vehicles with high mileage. This addition increased the fleet size to 23 transit buses in a condition that required a large amount of maintenance to enable them to provide regular revenue service.

Inadequate and Obsolete Buses

Although presented together, these are two different factors that have a substantial impact on seven of the Virginia operating properties. The use of inadequate equipment leads to a high rate of mechanical failures and, in turn, a large maintenance commitment to keep the equipment operating effectively. The properties affected by this factor include Harrisonburg, Winchester, and Charlottesville. This type of vehicle is usually smaller than a standard-size transit bus and in the Virginia properties reviewed it includes vehicles of both foreign and domestic manufacture.

It is noted that the term "inadequate" does not apply in any manner to the engineering, materials, or construction of the vehicles. It means that the vehicle was not as durable or maintainable as expected in the type of revenue service for which it was used, regardless of the service use recommended by the manufacturer. The question of whether the vehicles were inadequate or the application chosen by the property was inappropriate is not addressed here, as such an undertaking in itself would require a major study effort.

Obsolete equipment was a factor in the properties at Danville, Staunton, Bristol, and the four properties listed above. The use of obsolete equipment makes it difficult to obtain the necessary maintenance parts, particularly those parts for major component and subassembly rebuilding and repair. This difficulty often forces an operator to use an outside vendor for repairs and rebuilding, even though the maintenance personnel at the property have the skill necessary for the required task. In addition, a bus may be out of service much longer than normal for a particular type of repair due to the unavailability of parts.

A certain number of these problems can be expected in any fleet with old vehicles; however, it is compounded when these vehicles have major components and subassemblies that are no longer produced or made available by the original manufacturer. What is not so readily expected is that a 5- or 6-year-old bus will be obsolete by virtue of its foreign origin and discontinued availability in the United States. Having to rely on a foreign manufacturer often increases vehicle downtime.

All of the items presented here increase the time, effort, and cost of maintaining inadequate and obsolete transit vehicles at a level necessary to provide reliable passenger service.

Design of and Skill Level to Maintain the ADB

These two factors are closely enough interrelated to be discussed together. Neither is controlled by the operating property and both are highly influenced by federal policy. Because the design features of the ADB include a complex climate control system, numerous electronic devices, and other mechanical aspects such as wheelchair lifts, in revenue service this bus must be maintained at a higher level than previously used equipment in order to ensure service reliability. It was found that a higher number of component and subsystem failures was being experienced than was expected, even for a new design. While this high rate of

failure had already been discussed at some length, it is again pointed out here since the vehicle design, in the case of the ADB, seems to be the major determining factor in the performance of the buses in revenue service. The properties that had acquired the ADB — Tidewater, Roanoke, and Petersburg — were not prepared for the numerous repairs necessary to keep these buses operating at a reasonable level of reliability and as a result were experiencing difficulty in their overall maintenance programs.

In addition to the time and effort necessary to repair the many failures, being more complex than its predecessor the ADB requires a maintenance force with a similar increase in skill level. Because this skill level is not found in all transit bus mechanics, additional training is necessary, even for top-level maintenance personnel.

Only three properties were found to be affected by these two factors; however, this situation will change greatly in the next 3 to 4 years. It is expected that 10 properties will purchase a total of 118 new buses by 1985. This figure represents approximately 18% of the total fleet now operated by the properties reviewed for this report and a possible increase of 6 properties operating the ADB. An 18% fleet replacement with new operating equipment would usually be accompanied by a decrease in the total maintenance effort and cost. In this case, just the opposite may happen should the observations and information collected in this research prove to be an accurate predictor of transit bus maintenance trends over the next 4 years. If so, it is highly probable that the maintenance effort will need to be expanded substantially as a result of increased ADB use alone, while not even considering the added maintenance for such things as increased ridership and service levels.

Inadequate Number of Spare Buses

A certain number of spare buses are necessary for a proper approach to preventive maintenance. Buses must be held out of service for inspection and repairs and these buses must be replaced by spares.

The number of spares necessary is a function of local operating conditions and the level of vehicle maintenance practiced. In general, a small property would need a larger percentage of its fleet as spares than a large property due to its smaller capacity for maintenance. It would also be expected that vehicle age would be a factor, but, as previously discussed, the use of the ADB may well require a larger percentage of spares than would equipment used previously.

A property that must operate, for whatever reason, with an inadequate number of spares is very likely to experience a high rate of road calls and emergency breakdowns caused by deferring maintenance in order to keep the required number of buses in service. This, in turn, has a negative effect on ridership and revenue.

As the number of in-service breakdowns increases, passenger perception of the system reliability decreases. The bus is no longer viewed as a viable transportation alternative and ridership decreases. The loss of riders translates into a loss of revenue. Lost revenue means a decrease in operating funds that in all probability will result in decreased funds for maintenance. A decrease in maintenance funds will be reflected by an escalating deferment of vehicle maintenance that in turn will increase the number of in-service breakdowns as the cycle comes full circle.

Lack of Transit Vehicle Expertise

This factor affects most all the others. The operation of a transit system is a very complicated endeavor. In the municipal systems and several of the transit only systems much of the necessary expertise concerning the transit vehicle was not available. This was to be expected in light of the size of the systems and the number of maintenance employees. Vehicle specifications, maintenance facilities, maintenance equipment and tools, training, maintenance schedules, parts storage and availability, and maintenance planning combine into a major undertaking in any fleet operation, but these become additionally difficult when transit buses are included in the fleet. Transit bus expertise in these areas usually was not found in the municipal and small systems observed.

The majority of federal and state capital grant funds for the support of public transit are used in the purchase of transit vehicles and maintenance facilities. The Public Transit Division of the Virginia Department of Highways and Transportation administers these funds but does not have access on a permanent basis to the expertise necessary in the area of transit bus maintenance. As long as this situation continues, the small operators in Virginia will not have a source of unbiased expertise to call upon when necessary in their attempt to assure that the taxpayers' investment is being properly protected. This factor can be easily addressed by having a person knowledgeable in transit vehicles, maintenance facilities, and transit bus maintenance at the disposal of the Public Transit Division. An individual with this knowledge who is not connected with a vehicle manufacturer or a transit operation could serve as an unbiased consultant

both on and off the transit operation sites and assist the transit operators with any technical problems. He could also concurrently pursue research for the purpose of anticipating and targeting future problems that will affect transit operations in Virginia.

MAINTENANCE STANDARDS

Until the present there has been no attempt by the federal or state governments to review the maintenance of transit equipment purchased with grant funds. There is no accountability for these funds that assures the equipment will receive the best possible maintenance and thus provide maximum service to the public.

The various factors affecting the performance of transit vehicle maintenance have already been discussed. It is evident from the material presented in this report that the operating properties cannot be held entirely responsible for the current situation in transit vehicle maintenance. The proposed federal approach to the problem is a program of mandatory maintenance for the transit vehicles purchased with capital grant funds; however, a federal mandate for vehicle maintenance will not increase the performance of maintenance unless the factors previously discussed are addressed and relief in those areas is provided to transit operations.

The maintenance standards proposed here are meant to be applied at the state level to all operating properties that receive state funds. It is also recommended that all properties who do not receive funds adopt these standards in the effort to increase the quality of vehicle maintenance.

Adoption of the standards presented here and implementation of the recommendations contained in the next section of the report will provide the necessary protection for the already considerable capital investment in transit in Virginia, and will provide a continuing insurance for future investments. This action will give the transit operators the assistance they need to combat external factors affecting maintenance performance and provide accountability for capital funding grants.

This approach places the burden of compliance on the operators, but at the same time provides them with the tools and assistance necessary to meet that responsibility in such a way as to allow the standards to be fashioned to local conditions. The enormous variations in local operating conditions in Virginia make this type of approach essential.

The maintenance standards proposed here will not dictate the type of maintenance activities to be carried out. Thirteen transit operations were reviewed in this study and all operated under different geographical conditions, used different types of equipment, and had that equipment maintained by mechanics of varying skills. For these reasons it is impossible to propose a maintenance standard for inspection schedules or component replacements that would be correct for more than one operation. It is recommended, however, that the maintenance supervisors of the properties reviewed in this report contact each other should the difference in their scheduled work be a significant one as indicated in Table 14 and Table 27. In this way, a dialogue concerning the maintenance activities for similar vehicles can be initiated among the maintenance personnel at the various properties.

The proposed standards are stated in general terms and deal with the organizational and administrative approaches to maintenance, not with the particular maintenance procedures or the activities they encompass. The wording is general to provide the flexibility necessary for implementation of the standards.

Transit vehicle maintenance is extremely site-specific and requires a unique blend of activities at each property. Therefore, it is impossible to mandate, for instance, specific goals and objectives, or a standard program of preventive maintenance schedules. The goal of the proposed standards is not standard vehicle maintenance, but a standard approach that will become familiar to each of the transit properties. These standards will promote an exchange of information and a mutual understanding of the operational aspects of transit vehicle maintenance as practiced by properties in Virginia.

The proposed maintenance standards are presented in the following list.

1. Formulation of specific goals and objectives targeted at the vehicle maintenance function and based on local operating conditions.

2. Implementation of an organized and systematic preventive maintenance program to include operator inspection, daily service inspections, and scheduled maintenance inspections.

3. Use of maintenance information forms which include the following as a minimum:

   a. Operator inspection (vehicle defect) forms.

   b. Detailed maintenance inspection forms designed for the transit vehicle being inspected.

c. Road call and emergency maintenance forms.

d. Detailed daily fuel, oil, and fluid use form.

e. Maintenance work order (repair order) form.

4. Systematic data collection and analysis to support the formulation and implementation of appropriate maintenance performance indicators and measures. This minimum data collection should include the following.

   a. Maintenance performed (type, mileage, description).

   b. Actual labor time for inspection, repair, and rebuilding .

   c. Parts used and cost for inspection, repair, and rebuilding .

   d. Component and subassembly replacements (new, rebuilt, or used replacements).

   e. Road calls (cause, action taken, labor time, time out of service, parts, resolution).

   f. Number of missed or late runs due to maintenance problems.

   g. Materials and supplies consumed per vehicle.

   h. Number of buses out of service, for what reason, and how long .

   i. Other data necessary due to local operating conditions.

5. Systematic maintenance planning for preventive and periodic maintenance based on the data collection and analysis proposed in standard 4.

6. Specific maintenance personnel assigned to inspection and repair of transit vehicles.

7. Minimum training requirements and competency qualification for maintenance personnel.

Several of the proposed standards should not be implemented until certain other actions are taken, in order to minimize the disruption and the cost shouldered by the transit operators. These actions are presented with the study recommendations in the next section. However, the remainder of the standards should be implemented with all due speed, as they represent no substantial burden for any of the operating properties.

RECOMMENDATIONS

1. The proposed standards numbers 1, 2, 3, and 6 should be implemented by the Virginia operating systems as soon as due process allows.

2. The proposed standards numbers 4, 5, and 7 should be the subject of further study by the Public Transportation Division as follows.

   a. Data collection and analysis should be discussed at further length with the operators at Lynchburg and Petersburg in order to initiate a VMMIS study effort and demonstration program.

   b. The work effort necessary to investigate the feasibility of various alternatives for providing needed maintenance training and implementing the chosen alternative should be initiated as soon as possible.

3. The Public Transportation Division should initiate an information exchange program at the state level to facilitate discussion and understanding —

   a. between the local political administrative and funding personnel responsible for transit and the transit operations and maintenance management personnel concerning the operational realities of providing reliable transit service to the local community;

   b. among the maintenance management personnel of the various transit systems in Virginia to provide technical and administrative support to each other; and

   c. for those properties which need assistance in formulating goals, objectives, and a realistic set of performance measures.

4. The Public Transportation Division should secure the services of a person knowledgeable about transit vehicles, maintenance facilities, and transit bus maintenance to provide any necessary assistance to transit systems in Virginia.

5. The Public Transportation Division should initiate further study of cooperative purchases, rebuilding, and bus procurement, especially as they relate to the needs of the small systems.

6. The Public Transportation Division should initiate further study of the alternatives for procuring transit bus tires.

7. The Public Transportation Division should initiate further study of in-house versus vendor use for component and sub-assembly rebuilding.

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APPENDICES

APPENDIX A

TRANSIT BUS INVENTORY

XIV. Transit Vehicle Inventory

A. Include all transit vehicles, which were active during the FY, either by category or individually.

Type of Vehicle*	Year of Manufacture	Manufacturer	Model Number(s)	Seating Capacity	Total Capacity (including standees)	Number of Vehicles Owned in Each Category	Number of Vehicles Leased in Each Category
Regular	1954	GMC	4512	45	67	4	-0-
	1974	FLX	450961	41	61	72	
	1962	GMC	4517	45	67	7	
	1971	GMC	4521A	45	67	1	
	1973	GMC	4504A	41	61	1	
	1965	GMC	5303	51	76	10	
	1966	GMC	5303	51	76	10	
	1968	GMC	5306A	51	76	12	
	1975	GMC	5308A	47	70	39	
	1975	AMG	9635A	41	61	30	
	1978	FLX	531028	47	70	26	

B. Total number of inactive vehicles in fleet: -0- vehicles.

*Note whether usage was for either regular, school, or charter bus service

All items in A. for regular bus service.

XIV. Transit Vehicle Inventory

A. Include all transit vehicles, which were active during the FY, either by category or individually.

Type of Vehicle*	Year of Manufacture	Manufacturer	Model Number(s)	Seating Capacity	Total Capacity (including standees)	Number of Vehicles Owned in Each Category	Number of Vehicles Leased in Each Category
Bus	1980	GMC	RTS-2	36	72	20	- -
Bus	1979	Grumman Flxible	870	48	90	74	- -
Bus	1973	Flxible		47	90	47	- -
Bus	1969	GMC	5305-A	53	90	5	- -
Bus	1966	GMC	4519	45	90	8	- -
Bus	1960	GMC	4517	45	70	2	- -
Bus	1961	GMC	4517	45	70	1	- -
Bus	1962	GMC	5301	51	90	5	- -
Bus	1978	BL.BRDS	Cty. Tran.	31	60	10	- -

B. Total number of inactive vehicles in fleet: _____ vehicles.

*Note whether usage was for either regular, school, or charter bus service

XIV. Transit Vehicle Inventory

A. Include all transit vehicles, which were active during the FY, either by category or individually.

Type of Vehicle*	Year of Manufacture	Manufacturer	Model Number(s)	Seating Capacity	Total Capacity (including standees)	Number of Vehicles Owned in Each Category	Number of Vehicles Leased in Each Category
Bus	1953	Mack	C37DT 1304	37	56	1	0
Bus	1967	Flx	111CD-C1	51	77	10	0
Bus	1968	Flx	111CD-C1	51	77	10	0
Bus	1969	Flx	111CD-C1	51	77	6	0
Bus	1976	Flx	53096-8-1	47	71	43	0
Bus	1977	Flx	53096-8-1	47	71	40	0
Bus	1975	Mercedes	309D	23	35	6	0
Bus	1975	Mercedes	309D	15	23	2	0

B. Total number of inactive vehicles in fleet: _____ vehicles.

*Note whether usage was for either regular, school, or charter bus service

XIV. Transit Vehicle Inventory

A. Include all transit vehicles, which were active during the FY, either by category or individually.

Type of Vehicle*	Year of Manufacture	Manufacturer	Model Number(s)	Seating Capacity	Total Capacity (including standees)	Number of Vehicles Owned in Each Category	Number of Vehicles Leased in Each Category
Bus (R)	1964	GMC	TDH-3501	35	53	5	0
Bus (R)	1965	GMC	TDH-3501	35	53	4	0
Bus (R)	1969	GMC	TDH-3301	33	48	10	0
Bus (R)	1976	FLEX	4509	41	61	22	0
BUS (R)	1979	FLEX	870	41	61	13	0

B. Total number of inactive vehicles in fleet: _____ vehicles.

*Note whether usage was for either regular, school, or charter bus service

XIV. Transit Vehicle Inventory

A. Include all transit vehicles, which were active during the FY, either by category or individually.

Type of Vehicle*	Year of Manufacture	Manufacturer	Model Number(s)	Seating Capacity	Total Capacity (including standees)	Number of Vehicles Owned in Each Category	Number of Vehicles Leased in Each Category
BUS (R)	1969	GMC	3301	33	50	6	0
BUS (R)	1975	FLEX	45096-6-1	41	61	17	0
BUS (R)	1976	GMC	4523-A	41	61	4	0

B. Total number of inactive vehicles in fleet: _____ vehicles.

*Note whether usage was for either regular, school, or charter bus service

XIV. Transit Vehicle Inventory

A. Include all transit vehicles, which were active during the FY, either by category or individually.

Type of Vehicle*	Year of Manufacture	Manufacturer	Model Number(s)	Seating Capacity	Total Capacity (including standees)	Number of Vehicles Owned in Each Category	Number of Vehicles Leased in Each Category
Motor Bus	1975	Merc-Benz	0309	16	24	8	0
Motor Bus	1977	Blue Bird		31	45	4	0
Motor Bus	1960	GMC	4517	45	70	0	11

B. Total number of inactive vehicles in fleet: _____ vehicles.

*Note whether usage was for either regular, school, or charter bus service

VIV. Transit Vehicle Inventory

A. Include all transit vehicles, which were active during the FY, either by category or individually.

Type of Vehicle*	Year of Manufacture	Manufacturer	Model Number(s)	Seating Capacity	Total Capacity (including standees)	Number of Vehicles Owned in Each Category	Number of Vehicles Leased in Each Category
Omnibus	1965	GMC	3501	35	60	1	-0-
Omnibus	1966	GMC	3501	35	60	1	-0-
Omnibus	1967	GMC	3501	35	60	2	-0-
Omnibus	1978	GMC	7603	37	60	10	-0-
Chev. S.W.	1978	GMC	35083	8	8	1	-0-
Chev. Truck	1979	GMC	160A9	3	3	1	-0-

B. Total number of inactive vehicles in fleet: 1 vehicles.

*Note whether usage was for either regular, school, or charter bus service

XIV. Transit Vehicle Inventory

A. Include all transit vehicles, which were active during the FY, either by category or individually.

Type of Vehicle*	Year of Manufacture	Manufacturer	Model Number(s)	Seating Capacity	Total Capacity (including standees)	Number of Vehicles Owned in Each Category	Number of Vehicles Leased in Each Category
#721	1974	G.M.C.	T6H4523	A816	45		
#722	1974	G.M.C.	T6H4523	A817	45		
#723	1974	G.M.C.	T6H4523	A820	45		
#724	1974	G.M.C.	T6H4523	A818	45		
#725	1960	G.M.C.	TDH3714	413	32		
#726	1960	G.M.C.	TDH3714	815	32		
#727	1970	G.M.C.	TDH3714	816	37		
#729	1955	G.M.C.	TDH3714	412	32		
#731	1965	G.M.C.	TDH4519	876	45		
#732	1960	G.M.C.	TDH3714	814	37		

B. Total number of inactive vehicles in fleet: 0 vehicles.

*Note whether usage was for either regular, school, or charter bus service

XIV. Transit Vehicle Inventory

A. Include all transit vehicles, which were active during the FY, either by category or individually.

Type of Vehicle*	Year of Manufacture	Manufacturer	Model Number(s)	Seating Capacity	Total Capacity (including standees)	Number of Vehicles Owned in Each Category	Number of Vehicles Leased in Each Category
[illegible]	1967	G.M.C.	TDH	35	48	16	-0-
School	1970	G.M.C.	BE5-P102	66	88	2	-0-
[illegible]	1969	Ford	-	66	88	2	-0-
School	1964	Chevrolet	-	64	85	1	-0-
School	1972	International	1803	66	88	9	-0-

B. Total number of inactive vehicles in fleet: _____ vehicles.

*Note whether usage was for either regular, school, or charter bus service

XIV. Transit Vehicle Inventory

A. Include all transit vehicles, which were active during the FY, either by category or individually.

	Type of Vehicle*	Year of Manufacture	Manufacturer	Model Number(s) T.D.H.	Seating Capacity	Total Capacity (Including standees)	Number of Vehicles Owned in Each Category	Number of Vehicles Leased in Each Category
	Coach	1973	GMC	3302A	33	50	8	None
*	Conventional	1962	GMC	Sr40027	66	76	1	None
*	Conventional	1966	Ford	F750	66	76	3	None
*	Conventional	1968	GMC	SM5810	66	76	2	None
*	Conventional	1978	Chev.	7500	66	76	1	None

B. Total number of inactive vehicles in fleet: 0 vehicles.

*Note whether usage was for either regular, school, or charter bus service

* Buses Used for School Busing

XIV. Transit Vehicle Inventory

A. Include all transit vehicles, which were active during the FY, either by category or individually.

Type of Vehicle*	Year of Manufacture	Manufacturer	Model Number(s)	Seating Capacity	Total Capacity (including standees)	Number of Vehicles Owned in Each Category	Number of Vehicles Leased in Each Category
Motor Bus	1977	Ford & Blue Bird	Blue Bird	27	36	2	0
Motor Bus	1976	Ford & Blue Bird	Blue Bird	27	36	1	0
Motor Bus	1974	Intl & Blue Bird	Blue Bird	27	36	2	0
Motor Bus	1973	Intl & BB	Blue Bird	27	36	1	0
Motor Bus	1971	Intl &	Superior	27	36	1	0
Motor Bus	1969	Ford &	Wayne	27	36	1	0
Motor Bus	1968	Ford &	Wayne	27	36	1	0
Motor Bus	1966	Ford &	Wayne	27	36	1	0
Motor Bus	1965	Intl &	Wayne	27	36	1	0

B. Total number of inactive vehicles in fleet: 4 vehicles.

*Note whether usage was for either regular, school, or charter bus service

ALL BUSES USED FOR REGULAR SERVICE

XIV. Transit Vehicle Inventory

A. Include all transit vehicles, which were active during the FY, either by category or individually.

Type of Vehicle*	Year of Manufacture	Manufacturer	Model Number(s)	Seating Capacity	Total Capacity (including standees)	Number of Vehicles Owned in Each Category	Number of Vehicles Leased in Each Category
Mercedes-Benz	1976	Mercedes	0309D	19	25	4	-0-
Dodge	1976	Chrysler		12-15	15	1	-0-
Mercedes Benz bus -		fixed route					
Dodge van	-	fixed route					

B. Total number of inactive vehicles in fleet: -0- vehicles.

*Note whether usage was for either regular, school, or charter bus service

XIV. Transit Vehicle Inventory

A. Include all transit vehicles, which were active during the FY, either by category or individually.

Type of Vehicle*	Year of Manufacture	Manufacturer	Model Number(s)	Seating Capacity	Total Capacity (including standees)	Number of Vehicles Owned in Each Category	Number of Vehicles Leased in Each Category
Taxi	1977	Chevy	Nova	6	6	4	
Taxi	1977	Checker		9	9	3	
Taxi	1979	Chevy	Malibu	5	5	2	
Bus-Regular	1977	Chevy	Blue Bird	17	23	3	
School Bus	1978	Ford	Blue Bird	34	40	2	
School Bus	1980	Ford	Blue Bird	64	70	1	
Charter	1974	Ford	Van	12	12	1	
Charter	1974	Dodge	Van	15	15	1	
Charter	1980	Plymouth	Van	15	15	1	
Charter	1979	Chevy	Wheel Chair Van	6	6	1	

B. Total number of inactive vehicles in fleet: _____ vehicles.

*Note whether usage was for either regular, school, or charter bus service

APPENDIX B

TRANSIT BUS MAINTENANCE QUESTIONNAIRE WITH RESPONSES

VIRGINIA DEPARTMENT OF HIGHWAYS AND TRANSPORTATION
TRANSIT BUS MAINTENANCE QUESTIONNAIRE

MAINTENANCE FACILITIES

1. How many maintenance facilities do you have? _____

Facilities (No.)	Responses (N
1	13

2. Age of the maintenance facilities? _____

No. Years	No. of Responses
1	1
2	1
13	1
20	1
30	2
35	2
40	1
54	1
75	1
80	1

3. Do you feel the amount of maintenance equipment you now have is adequate?

__7__ Yes __6__ No

4. Do you feel the type of maintenance equipment you now have is adequate?

__5__ Yes __8__ No

5. Do you follow a maintenance equipment replacement policy or schedule?

__5__ Yes __8__ No

6. Have you conducted a study to determine the optimum placement and arrangement of your maintenance equipment?

__4__ Yes __9__ No

7. Would you consider such a study beneficial to your operation?

__8__ Yes __5__ No

MAINTENANCE PERSONNEL

8. What is your maintenance personnel turnover rate per year? ____% of maintenance perso

% Rate	No. of Responses
0	6
1	2
2	1
3	1
7	1
10	2

9. What is your service personnel turnover rate per year? ___% of service personnel

% Rate	No. of Responses
0	8
1	2
2	1
10	1
17	1

10. Do you experience difficulty in hiring qualified personnel? 12 Yes 1 No

11. Do you feel there is a need for a formal transit bus mechanic training program in Virginia? 13 Yes 0 No

12. Could you provide co-op positions for students from such a training program?

7 Yes 6 No

13. Do you have an active ongoing maintenance training program of your own?

2 Yes 11 No

14. Do you have an apprentice program? 4 Yes 9 No

MAINTENANCE PROCEDURES

15. Do you feel that you have complete "in-house" maintenance capability? 6 Yes 7 No

16. Do you feel that you need more "in-house" maintenance capability? 8 Yes 5 No

17. Do you contract out any service work? 4 Yes 9 No

18. Do you contract out any maintenance work? 5 Yes 8 No

19. Do you contract out any component or subassembly-rebuild work? 10 Yes 3 No

20. What percentage of your maintenance work is:

preventive ___%	Responses (No.)	Remedial ___%	Responses (No.)	Other ___%	Responses (No.
20	2	20	4	0	6
25	2	30	2	5	2
33	1	50	1	10	1
40	1	55	1	20	1
45	1	66	1	25	2
50	1	75	1	no comment	1
70	1	80	2		
75	1	no comment	1		
80	2				
no comment	1				

21. Do you feel that the maintenance manuals now provided by the bus manufacturer are adequate for your operation? 6 Yes 7 No

22. Do you have standard procedures for maintenance operations? 12 Yes 1 No
If yes, are they in written form? 9 Yes 4 No

23. Do you have a system of vehicle maintenance Records? 13 Yes 0 No
If yes, is it computerized? 3 Yes 10 No

24. Do you have a periodic (preventive) maintenance program? 12 Yes 1 No
If no, please skip to question 28.

25. What is your preventive maintenance program based on?

12 mileage 0 hours other 1

26. What amount of miles, hours, or other do you use for the basic maintenance interval?

no. miles ____ no. hours ____ other (please explain) ____

Miles	No. of Responses	Other	No. of Responses
1,500	1	Seasonal	1
2,000	2		
3,000	2		
4,000	1		
4,500	1		
5,000	1		
6,000	4		

27. How long have you used this interval? ____

Miles		Other	
Years	No. of Responses	Years	No. of Responses
1	2	20	1
2	2		
3	1		
5	1		
20	2		
22	1		
30	1		
no comment	3		

28. Do you routinely replace any components or subassemblies on a scheduled basis?

3 Yes 10 No

29. Please check the actions below that are common at your property.

12	Scheduled inspection of vehicles	7	Rebuild of major components for stock
13	Minor repairs and replacements	9	Replacement of subassemblies
13	Replacement of parts (hoses, belts, etc.)	7	Repair of subassemblies
13	Replacement of major components	5	Rebuild of subassemblies for stock
12	Repair of major components	8	Body and chassis structural repairs

30. How do your operators report defects to maintenance?

2 verbally 10 written form 1 no set procedure

31. How do your service personnel report defects to maintenance?

3 verbally 8 written form 2 no set procedure

MAINTENANCE PROBLEMS

32. Do you experience any "unusual" maintenance problems due to your type of operation?

6 Yes 7 No If yes, please explain.

Short tire, brake, and transmission life due to hilly terrain.

Inadequate maintenance equipment

Inadequate maintenance facilities

Limited manpower and mechanical ability.

33. Do you experience any "unusual" maintenance problems due to the type of vehicles you are operating? 10 Yes 3 No If yes, please explain.

Obsolete Buses

Inadequate Buses

Advanced Design Buses

BUS PURCHASES

34. Do you expect to purchase new buses within the next 3 years?

10 Yes 3 No If yes, how many? _____

No. of Buses	No. of Responses
1	1
3	1
4	2
5	2
8	1
11	1
30	1
47	1

35. Do you feel the types of buses currently available are compatible with your present maintenance operation? 11 Yes 2 No

36. Do you feel that your maintenance policies, practices and problems are adequately considered when new buses are purchased? 11 Yes 2 No

37. Do you feel that bus manufacturers are providing adequate technical assistance for bus purchasers? 7 Yes 5 No

38. What percentage of your present bus fleet are spares? ____%

% Fleet	No. of Responses
9	1
10	1
11	1
14	1
15	1
20	2
22	1
30	1
31	1
33	1
35	1
40	1

39. What percentage of a transit bus fleet do you feel should be spares? ____%

% Fleet	No. of Responses
15	1
20	4
30	1
33	1
35	1
40	1

40. Do you purchase or lease the tires for your buses? 6 purchase 7 lease 0 both

COOPERATIVE EFFORTS

The phrase "statewide cooperative" is used in the next three questions. By this we mean some type of organized effort, by the transit properties within the State of Virginia, to collectively order and purchase necessary items. The end result would be an increase in the purchase volume in order to obtain a lower or more stable purchase price. These questions are hypothetical and are asked in order to obtain your opinions on this concept. Should the responses indicate interest in these areas, the actual mechanics of application will be investigated.

41. Do you feel that a "statewide cooperative" purchase of parts and supplies for transit bus maintenance would be an asset to your operation? 6 Yes 7 No

42. Do you feel that a "statewide cooperative" rebuilding facility for all major components and subassemblies of transit buses would be an asset to your operation?

    7 Yes 6 No

43. Do you feel that a "statewide cooperative" purchase of transit buses would be an asset to your operation? 8 Yes 5 No

Questionnaire answered by: Name & Title _____

Address _____

Telephone Number ( ) _____

APPENDIX C

MUNICIPAL FLEET PREVENTIVE MAINTENANCE INSPECTION FORMS

WINCHESTER

LUBRICATION AND SAFETY CHECK SHEET

EQUIP. NO. _____ MILEAGE _____ DATE _____

HOURS _____ DRIVER _____

CAB

___ Check Operation of Starter _____

Check Operation of Engine _____

Check Operation of All Instruments and Gauges _____

Check Operation of All Lights _____

Check Windshield Wipers and Washers _____

Check Clutch Pedal Free Travel and Release _____

Check Brake Pedal Pressure and Adjustment _____

Check Parking Brake _____

Check Steering for Play in Wheel _____

Check Heater and Defroster _____

___ Check Window Glass and Winding Mechanism _____

HOOD

Lubricate Alternator, Generator, Distributor _____

Check Radiator for Proper Coolant Level _____ Test Antifreeze _____

Check Belts for Adjustment and Condition _____

Clean All Battery Connections, Fill Battery with Water _____

Fill Brake and Clutch Master Cylinders _____

___ Check Steering Gear Lubricant or Power Steering Fluid _____

VEHICLE

Check Springs, Clamps, and Shackles _____

Check Steering for Loose Bushings, Spindles and Tie Rods _____

Check Exhaust System for Leaks or Looseness _____

Lubricate Clutch Release Bearing and Clutch and Brake Pedal Linkage ___

Lubricate Hoist _____

Check Level of Transmission Lubricant _____ (Amount _____)

Check Level of Rear End Lubricant _____ (Amount _____)

Change Engine Oil _____ (Amount _____ Qts) Weight _____

Change Oil Filter Cartridge _____ Cart No. _____

Check All Tires for Condition and Inflation _____

___ Lubricate All Grease Fittings with Proper Lubricant _____

Mileage/Hours changed on Bulletin Board _____

I have performed all the operations checked above.

_____

Mechanic's Signature

List anything requiring additional attention on back of this sheet.

Note: Pull wheels and check brake lining and drums on City Buses every 5000 miles.

DANVILLE

CITY OF DANVILLE

MECHANICS MONTHLY VEHICLE INSPECTION

Veh. NO. _____ MAKE: CHASSIS _____ BODY _____ SPEEDOMETER READING _____

COUNTY or CITY _____ DRIVER _____

This is to certify that I have this day made a careful inspection of the vehicle described above and make a report as follows:

	GOOD	CORRECTED
1. BRAKES		
General Condition of Service Brake		
Pedal Pressure and Adjustment		
Gauges, Buzzers, and lights		
Master Cylinder		
Vacuum Booster or Air Compressor		
Vacuum Tanks or Air Tanks		
Air Pressure Relief and Bleeder Valves		
Parking Brake		
2. STEERING		
Play in Wheel		
Spindles, Bushings, Tie-rod		
Alignment and Balance		
Power Lines and Belt		
3. TIRES		
Front: Right and Left		
Inside Rear: Right and Left		
Outside Rear: Right and Left		
Inflation		
4. ENGINE		
Crankcase Ventilator		
Governor Setting		
Engine Mountings		
Radiator		
Fan Belt		
Water Pump and Hose		
Fuel Tank, Lines and Carburetor		
Exhaust System		
Oil Filter and Lines		
Alternator and Regulator		
Battery and Starter		
Distributor and Wiring		
Horn		
5. CLUTCH AND TRANSMISSION		
Pedal Release and Clearance		
Univ. Joints and D.S. Bearings		
Transmission Shifting		

	GOOD	CORRECTED
6. AXLES, FRONT AND REAR		
Springs, Clamps and Shackles		
Wheel Nuts and Bearings		
7. LIGHTS		
Traffic Lights and Pilot		
Motor Flasher Assembly		
Front and Rear Directional Signals		
Directional Signal Switch and Pilot		
Four-Way Hazard Warning System		
Head and Tail Lights		
Stop Light and Pilot		
Clearance		
Identification		
Back up		
8. BODY		
Condition of Seats		
Driver and Seat Belt		
Front Door and Control		
Condition of Stanchions		
Emergency Door and Lock		
Emergency Door Buzzer		
Windshield		
Windshield Wipers and Washers		
Windows (Broken)		
Mirrors, Inside and Outside		
Heater, Defroster, and Defogging Fan		
Mounting Clamps		
9. MISCELLANEOUS		
Cleanliness of Interior		
Speedometer		
Instruments or Gauges		
Front Fenders and Grill		
Bumpers, Front and Rear		
First Aid Kit		
Flags and Flares		
Fire Extinguisher Pressure		
Free of Posters (Advertising)		
Free of Bottles and Loose Objects		
Lettering		

REMARKS: _____

DATE _____ _____

Inspecting Mechanic

SUPERINTENDENT'S COPY

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JAMES CITY COUNTY

SCHEDULE
PM GROUP "F"

"C" - Check
"R" - Replace
"S" - Service

Service (Per 1000 mi.)	5	10	15	20	25	30	35	40	45	50	55	60
Oil & Filter	R	R	R	R	R	R	R	R	R	R	R	R
Chassis Lube			S			S			S			S
Air Cleaner	C	C	R	C	C	R	C	C	R	C	C	R
Tire Rotation												
Front Wheel Brngs		C		S		C		S		C		S
Brake Lining			C			C			C			C
Fuel Filter			R			R			R			R
Emission Controls	C	C	C	C	C	C	C	C	C	C	C	C
"U" Joints		C		C		C		C		C		C
Auto Trans	C	C	C	S	C	C	C	S	C	C	C	S
Rear Axel	C	C	C	C	C	S	C	C	C	C	C	S
Power Steering	C	C	C	C	C	C	C	C	C	C	C	C
Battery	C	C	C	C	C	C	C	C	C	C	C	C
Windshield Wash	C	C	C	C	C	C	C	C	C	C	C	C
Radiator Coolant	C	C	C	C	C	R	C	C	C	C	C	R
Drive Belts	C	C	C	C	C	C	C	C	C	C	C	C
Shocks	C	C	C	C	C	C	C	C	C	C	C	C
Wiper Blades	C	C	C	C	C	C	C	C	C	C	C	C
Lights	C	C	C	C	C	C	C	C	C	C	C	C
Mirrors	C	C	C	C	C	C	C	C	C	C	C	C
Tire Pressure	C	C	C	C	C	C	C	C	C	C	C	C
Door Hinges	C	C	C	C	C	C	C	C	C	C	C	C
Front Suspension	C	C	C	C	C	C	C	C	C	C	C	C
Hoses	C	C	C	C	C	C	C	C	C	C	C	C
Air Tank Drain	S	S	S	S	S	S	S	S	S	S	S	S
Cost of Service	18.00	18.00	36.12	42.00	18.00	54.00	18.00	42.00	36.12	18.00	18.00	78.00
Less Parts, Etc.												

MECHANICAL DEPARTMENT
INSPECTION WORK SHEET

BUS NO._____ DATE_____ SPEEDOMETER_____

AM HOURS_____ HELPER_____

REPAIRS NEEDED_____

1. Check play in steering_____
2. Check C-1 governor operation_____
3. Check clutch and shifting mechanism for operation_____
4. Try handbrake_____
5. Record oil pressure_____
   Max._____ Min._____
6. Check generator for charging_____
7. Check lights interior_____
   exterior_____
8. Test wipers_____
9. Test heating and ventilation motors_____
10. Test Buzzer_____ Horn_____
11. Test Fire extinguisher_____
12. Inspect body: interior_____
    exterior_____
13. Fill and test battery, tighten terminals_____
14. Test brake mechanism for application_____; Release_____; Leaks_____
15. Tighten drive line bolts_____
16. Adjust brakes_____
17. Check all spring conditions_____
18. Drain Air tanks_____
    separators_____; strainers_____
19. Check Plugs and Points_____
20. Check Carburetor_____
21. Adjust Clutch_____
    Lubricate throwout bearing_____
22. Check Grease Level in Transmission and Differential_____
23. Check Radiator and Air Hose_____
24. Oil and Inspect Petal Controls_____
    Throttle Leakage_____
25. Check and Lubricate Distributor_____
26. Start Engine, Check for Leaks
    Oil____Gas____Air____Water_____
27. Correct or report any other trouble of any kind_____
28. Check Air Pressure and Defects in Tires_____

REMARKS:_____

APPENDIX D

MUNICIPAL FLEET MAINTENANCE INFORMATION FORMS

Fund No. ______
Dept. No. ______
Acct. No. ______
Veh. No. ______

CITY of DANVILLE

GARAGE WORK ORDER

DATE SIGNED IN ______
DATE COMPLETED ______
SPEEDOMETER READING ______

PARTS

QTY.	STOCK NO.	DESCRIPTION	UNIT COST
TOTAL PARTS			

SERVICE REQUIRED

BRAKES
- [ ] HAND
- [ ] FOOT

DRIVE TRAIN
- [ ] MOTOR KNOCKS
- [ ] MOTOR HEATS
- [ ] MOTOR MISSES
- [ ] MOTOR NO POWER
- [ ] CARBURETOR
- [ ] CLUTCH
- [ ] TRANSMISSION
- [ ] DRIVESHAFT
- [ ] UNIVERSAL
- [ ] REAR END
- [ ] AXLE
- [ ] STEERING

SERVICE
- [ ] OIL CHANGE
- [ ] LUBRICATE
- [ ] OIL FILTER
- [ ] AIR FILTER
- [ ] FLAT TIRE
- [ ] WASH

ELECTRICAL
- [ ] BATTERY
- [ ] HORN
- [ ] HEAD LIGHTS
- [ ] TAIL LIGHTS
- [ ] STOP LIGHTS
- [ ] STARTER
- [ ] ALTERNATOR
- [ ] IGNITION

MISCELLANEOUS
- [ ] RADIATOR
- [ ] HEATER
- [ ] WATER HOSES
- [ ] ANTI-FREEZE
- [ ] HYD. SYSTEM
- [ ] WELDING
- [ ] STATE INSP. STICKER

SPRINGS
- [ ] FRONT
- [ ] REAR

DETAILED DESCRIPTION OF WORK REQUIRED

LABOR

EMP. #	TIME ON - OFF	TOTAL HRS.
	OFF	
	ON	
	OFF	
	ON	
	OFF	
	ON	
	OFF	
	ON	
	OFF	
	ON	
	OFF	
	ON	
	OFF	
	ON	
	OFF	
	ON	

TOTAL LABOR ______
TOTAL PARTS ______
TOTAL REPAIR COST ______

WORK TO BE DONE

☐ Grease	☐ Change Oil	☐ Change Filter El.	☐ Inspection
☐ Steam Clean Motor	☐ Change Hydra-matic Trans. Fluid & Filter	☐ Change Angle Gears Grease	☐ Change Diff Grease

MATERIAL COST

Quantity	Part No.	Description	Cost	

City Bus System REPAIR ORDER

NAME _____

DATE _____ BUS NO. _____ MILEAGE _____

DESCRIPTION OF WORK DONE

LABOR COST

Name	Hours	Rate	Cost	
Total Labor				
Total Parts				
Oil				
Grease				
Hydra-matic Trans. Fluid				
Angle Gear Grease				
Diff. Grease				
Total Amount				

BRISTOL

City Bus System

PUMP READINGS: Diesel #1

ENDING _____

BEGINNING _____

GALS. PUMPED _____

Date

Bus No.	Gallons Diesel	Cost Diesel	Qts. Oil	Cost Oil	Reading Hubodometer	Previous Reading	Mileage
2							
4							
6							
8							
10							
12							
14							
16							
18							
20							
22							
24							
26							
28							
30							
32							
SHOP							

DRIVER'S VEHICLE CONDITION REPORT

Vehicle No. _____ **Date** _____

Driver _____ ☐ **A.M.** **Driver** _____ ☐ **P.M.**

	DRIVER'S REPORT	MECHANIC'S REPORT
Drive line		
Tires and wheels		
Springs		
Glass		
Emergency equipment:		
Torches, lanterns, reflectors		
Fusees		
Flags		
Spare bulbs		
Fuses		
First-aid kit		
Axe		
Fuel system		
Cooling system		
Engine		
Leaks		
Lights:		
Head		
Tail		
Stop		
Clearance and marker		
Reflectors		
Oil pressure		
Ammeter		
Horn		
Windshield wipers		
Parking brakes		
Clutch		
Transmission		
Rear vision mirrors		
Steering		
Service brakes		
Speedometer		
Other items requiring attention:		

Remarks:

STAUNTON

STAUNTON TRANSIT SERVICE

MONTHLY REPORT

DATE: _____

REGULAR COACHES

Total Revenue For Month _____ Total Revenue To Date _____

Revenue From Cash Fares _____

Total Passengers For Month _____ Total Passengers To Date _____

Number Of Transfers _____

Total Mileage _____ Total Mileage To Date _____

Diesel Fuel _____ Diesel Oil _____ Total Service Jobs _____

Number Of Buses _____ Total Employees _____

SCHOOL BUSES

Total Revenue For Month _____ Total Revenue To Date _____

Revenue From Cash Fares _____ Revenue From School Tickets _____

Total Passengers For Month _____ Total Passengers To Date _____

Number Of Transfers _____

Total Mileage _____

Gas Used _____ Motor Oil _____

Number of Buses _____ Total Employees _____

_____

Bill Cox, Supervisor

GASOLINE AND OIL REPORT

DATE	TIME		BUS NO.	SPEEDOMETER	GAS	OIL	GREASE	TRANS.	DIFF.	FILTER CART.	SIGNATURE
				TOTAL							

SHOP TIME

DATE _____

EMPLOYEE _____

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

TOTAL HOURS _____

BY _____

DATE: _____ TIME: _____

EQUIPMENT: _____

REPAIRS NEEDED: _____

_____

_____

_____

REMARKS: _____

DRIVER: _____

_____

_____

DATE REPAIRS COMPLETED: _____

REMARKS: _____

_____

_____

_____

MECHANIC: _____

Roadcall Form

DATE: _____ TIME: _____

EQUIPMENT: _____

REPAIRS NEEDED: _____

_____

_____

_____

REMARKS: _____

DRIVER: _____

HOURS: _____ MILES: _____

_____

DATE REPAIRS COMPLETED: _____

REMARKS: _____

_____

_____

MECHANIC: _____

Driver Defect Form

√		INIT.	COST		MUNICIPAL GARAGE CITY OF HARRISONBURG				REPAIR PARTS (INCLUDE ACCESSORIES)		
	OIL CHANGE								QUAN.	DESCRIPTION	COST
	WT. QTS.				DEPT.						
	OIL FILTER				DIV.						
	DIESEL FILTER				VEH. NO.						
					LIC. NO.						
	TOTAL OIL				IN.			A.M. P.M.			
					OUT			A.M. P.M.			
	LUBE & SERV.				OK'D BY						
	LUBRICATE				ORDER NO.						
	HOIST OIL										
	WINCH OIL										
	REAR END OIL										
	FRONT END OIL				OIL						
	TRANSMISSION OIL				LUBE & SERVICE						
	BRAKE FLUID PT.				TIRES & TUBES						
	AIR CLEANER SER.				OUTSIDE REPAIRS						
	WASH				REPAIR PARTS						
	WAX				LABOR						
					TOTAL COST				(USE OTHER SIDE IF NECESSARY)	TOTAL REPAIR PARTS	
	TOT. LUBE & SER.				OTHER INSTRUCTIONS				HRS.	INIT.	
	TIRES & TUBE										
	FLAT(S)										
	ROTATE										
	BALANCE										
	TIRES (SIZE-PLY)										
	TUBES										
	TOT. TIRES										
	O/S REPAIRS										
	TOTAL O/S REP.				(USE OTHER SIDE IF NECESSARY)				TOTAL LABOR		

DRIVER'S VEHICLE CHECK LIST

Vehicle No.....Date.....

Check defects or needed equipment— ☑ . Explain the defect or need under "Remarks" and include other conditions not shown, which need attention.

☐ Brakes	☐ Leaks
☐ Horn	☐ Engine
☐ Tires	☐ Steering Mechanism
☐ Glass (State Which)	☐ Heater
☐ Lights (State Which)	☐ Emergency Equipment
☐ Windshield Wiper	☐ Body
☐ Speedometer	☐ Coupling Device
☐ Rear View Mirror(s)	☐ Directional Lights

Remarks:.....

.....

.....

.....

.....

.....

.....

.....

Driver's signature.....

SHOP REPORT

Above conditions have been corrected.

(If not, explain).....

.....

.....

.....

.....

Date:.....by.....

IEA 17 10-59 C

APPENDIX E

TRANSIT ONLY
PREVENTIVE MAINTENANCE INSPECTION FORMS

M-4 Rev. 8-22-78

COACH INSPECTION

Inspection No. _____

Coach No. _____

Fuel-Hi. Per Gal. _____

Oil- Hi. Per Qt. _____

Date Due _____ Mileage _____ Date Completed _____

Description Engine	#	Rep. Made	Adj.	OK	Mech Int.
Overhead Valves Inj. Rack					
Gov. Set: Idle ____ Full ____					
Accel. Control Linkage					
Eng. Air Intake and Filter					
Eng. Support Mountings					
Radiator, Fan, Shutters					
Air, Oil, Water & Fuel leaks					
All Hose & Belts					
Oil Pressure: Idle ____ Full ____					
Air Box Pressure	4				
Crankcase Pressure	4				
Exhaust Back Pressure	4				
Chassis					
Axle Studs Wheel Lugs					
Tire Rods Drag Link					
Suspensions: Bellows					
Shock Absorb. Sway Bar					
Brake Linings					
Hand Brake Link. Adj.					
Brake App. Valve					
Quick Release Valve					
Transmissions 450 rpm-2140 rpm					
Main Oil Pres. ____ ____	3				
Conv. in Pres. ____ ____	3				
Conv. out Pres. ____ ____	3				
Gov. Set. ____ Over-Drv. ____					
Adj. Shift Cables					

Description Body	#	Rep. Made	Adj.	OK	Mech Int.
Outside Panel Glasses					
Int. Floor-Steps-Panels					
Seats-Stanchions-Doors					
Windshield Wash. Fill-Check					
Windshield Wiper-Blades					
Electrical					
Battery: Water-Cables-Tray					
Starter: Cables					
Voltage Regulator-Setting					
Lights-Interior-Exterior					
Clean GRAD-U-STAT - Drain					
Heaters-Defrost-Pumps					
Switches-Fuses-Buzzers-Horn					
Emergency Warning System					
All Bug Lights Must Operate					
Lubrication					
Change Engine Oil					
Transmission Oil Level					
Differential Oil Level					
Lubricate Chassis					
Filters-Oil					
Water					
Fuel					
Air					
Fluid					
Run Engine-Check Leaks					

Unit Changes
Check A/C Oper.
Check A/C Altenat
Tires
L.F.
R.F.
R. Inside
R. Outside
L. Inside
L. Outside

NOTE: Defective Items Not Repaired-List on back of Card. All readings of RPM and Pressures must be listed. Voltage Regulator reading must be taken and listed. Foreman _____

BUS INSPECTION

Bus No. _____ No. _____

Date Due _____ Mileage _____ Date Completed _____

FUEL MILES PER GAL. _____

OIL MILES PER QT. _____

DESCRIPTION	REP. MADE	ADJ.	OK	MECH. INIT.
ENGINE AND TRANSMISSION				
Overhead Valves, Injector Rack				
Stall Idle Gov.				
Accelerator Control Linkage				
Engine Air Intake and Filters				
Engine Support Mountings				
Radiator, Fan and Shutters				
Air, Oil, Water and Fuel Leaks				
Air Comp. Time to Fill Tanks				
Adj. Clutch Shift Cables				
Pulleys and Belts				
FUEL SYSTEM				
Carb. Pump Filter				
IGNITION SYSTEM				
Distrib. Plugs Timing				
Coil Wiring				
CHASSIS				
Axle Studs Wheel Lugs				
Tie Rods Drag Link				
Suspension: Springs Bellows				
Shock Absorbers Sway Bars				
Brakes—Lining Thickness				
Hand Brake Linkage Adj.				
Quick Release and Application Valve				
TOE ADJUSTMENT				

DESCRIPTION	REP. MADE	ADJ.	OK	MECH. INIT.
BODY				
Outside Panels				
Cracked Glass				
Interior—Floor—Steps—Panels				
Seats - Stanchions				
Doors—Front—Speed				
Rear—Treadles—Speed				
Windshield Wipers - Speed - Blades				
ELECTRICAL				
Battery: Voltage Gravity				
Water—Cables - Grease Cradle				
Generator — Brushes — Commutator				
Starter - Brushes — Commutator				
Solenoid—Cables				
Voltage Regulator—Setting Cables				
Interior and Exterior Lights				
Horn—Instrument Panel				
Heaters and Defrosters				
Switches - Fuses - Buzzers				
Emergency Warning System				
LUBRICATION				
Change Engine Oil and Filters				
Transmission Oil Level				
Convertor Oil Level				
Differential Oil Level				
Lubricate Chassis				
Run Engine—Check for Leaks				
Engine Oil Pressure: Hot Cold				

GREASE CRADLE

OIL FILTER

UNIT CHANGES

TRANSMISSION FLUID PRESSURES	
Hydraulic	
Direct	
Main	
Conv. Out Idle	

RPM _____

TORQ. FLUID & FILTER

FUEL FILTER

VALVE COVER

ENGINE TUNE-UP

TORQUE BODY BOLTS

TRANSMISSION

NOTE: Circle Items Repaired.

Defective Items Not Repaired List on Back of Card.

Foreman's Signature

JCF M9

BUS INSPECTION

No.

Bus No.

FUEL MILES PER GAL.

Date Due Mileage Date Completed

OIL MILES PER QT.

DESCRIPTION	REP. MADE	ADJ	OK	MECH. INSP.
ENGINE AND TRANSMISSION				
Overhead Valves, Injector Rack				
Stall Idle Gov				
Accelerator Control Linkage				
Engine Air Intake and Filters				
Engine Support Mountings				
Radiator, Fan and Shutters				
Air, Oil, Water and Fuel Leaks				
Air Comp. Time to Fill Tanks				
Adj. Clutch Shift Cables				
Pulleys and Belts				
FUEL SYSTEM				
Carb. Pump Filter				
IGNITION SYSTEM				
Distrib. Plugs Timing				
Coil Wiring				
CHASSIS				
Axle Studs Wheel Lugs				
Tie Rods Drag Link				
Suspension: Springs Bellows				
Shock Absorbers Sway Bars				
Brakes—Lining Thickness				
Hand Brake Linkage Adj.				
Quick Release and Application Valve				
Air Box Pressure				
Blower Restriction				
Secondary Filter Pressure				
Primary Drain & Clean				
Tighten All Water Hose				
Tighten Heater Hose & Air Duct				

DESCRIPTION	REP. MADE	ADJ	OK	MECH. INSP.
BODY				
Outside Panels				
Cracked Glass				
Interior – Floor—Steps– Panels				
Seats - Stanchions				
Doors—Front—Speed				
Rear –Treadles—Speed				
Windshield Wipers—Speed—Blades				
ELECTRICAL				
Battery: Voltage Gravity				
Water—Cables—Grease Cradle				
Generator—Brushes—Commutator				
Starter—Brushes—Commutator				
Solenoid—Cables				
Voltage Regulator—Setting Cables				
Interior and Exterior Lights				
Horn—Instrument Panel				
Heaters and Defrosters				
Switches—Fuses—Buzzers				
Emergency Warning System				
LUBRICATION				
Change Engine Oil and Filters				
Transmission Oil Level				
Convertor Oil Level				
Differential Oil Level				
Lubricate Chassis				
Run Engine—Check for Leaks				
Engine Oil Pressure: Hot Cold				

UNIT CHANGES

NOTE: Circle Items Repaired.

Defective Items Not Repaired List on Back of Card.

CHECK WHEEL ALIGNMENT

Foreman's Signature

JCT M9

GREATER ROANOKE TRANSIT COMPANY
FLX INSPECTION

DATE_____ __3,__6,__12,__15,__21,__24. BUS NO._____

	MECHANIC		MECHANIC
1. Clean engine, radiator and battery		10. Complete lubrication job	
2. Check daily service card and write up		11. Drain air tank and check spit valve operation	
3. Check horn, windshield wipers and washers		12. Check gauges and warning lights	
4. Check mirrors, inside lights and buzzer		13. Check all exterior lights	
5. Check windows, seats, floor and fire extinguishers		14. Check heating and A.C. system (in season)	
6. Check doors, sensitive edge		15. Check heating and A.C. filters	
7. Check battery, electrolyte level and terminals		16. Check operations of all controls; steering, brakes, shifting, etc.	
8. Check engine transmission and differential lube level		17. Check for leaks - water, oil, air, and fuel	
9. Check brakes, adjust, lubricate cams		18. Check anti-freeze (in season)	

Check & lubricate front & side destination signs.

Record Tire Pressures - RRO_____RRI_____LRO_____LRI_____RF_____LF_____Inflate (80 lbs.)

Check engine and transmission oil level before and after Road Test _____
(Signature)

Record Body Damage_____

9,000 MILE INSPECTION

	MECHANIC		MECHANIC
1. Change engine oil, small filter, and by-pass filter		8. Check brake block, cam bearings and drums	
2. Check engine mounts and cradle		9. Check all water and air hoses, clamps and fittings	
3. Check exhaust system		10. Check all dust pans	
4. Check suspension system, radius rods, bushings and shocks		11. Check emergency stop	
5. Check drive line, universal and differential pinion		12. Check shutters and fluid fan operation	
6. Check steering gear and linkage, King pins, bearings and tie rod ends		13. Torque wheel stud nuts (500 FT. LBS.) Check axle flange nuts	
7. Change Out Oil!		14. Road test after all known defects are corrected	

Sign your name by items you have checked. Road failures cannot be avoided with paper and pencil inspections.

FOREMAN'S FINAL O.K._____

ROANOKE

FLX 18,000 MILE INSPECTION

	MECHANIC
1. Change trans. filters	
2. Change fuel filters	
3. Check and clean air filter	
4. Check door controls and lubricate linkage	

27,000 MILE INSPECTION

1. Check starter, regulator and generator	
2. Check wheel bearing adjustments.	
3. Check air compressor output	
4. Check toe in and front wheel balance	
5. Check governor R.P.M.	
6. Change differential oil	
7. Change air cleaner and perry water filter	
8. Change trans. fluid	

LUBRICATE WHEEL STUDS AND INSPECT TREADS AT EACH WHEEL CHANGE

REPACK WHEEL BEARINGS AT EACH BRAKE RELINE

SET TOE IN AND BALANCE FRONT WHEELS WHEN FRONT TIRES ARE CHANGED.

DATE_____ TYPE INSPECTION_____

BUS NO._____

GREATER LYNCHBURG TRANSIT CO.
FLXIBLE AND T6H-4523-A INSPECTIONS
6,000 - 12,000 - 24,000

Change oil and oil filters	MECHANIC	Change fuel filters	MECHANIC
1. Clean engine, radiator and battery; A. C. Compressor.		20. Check emergency stop.	
2. Check Daily Service Cards and repeated Write-Ups.		21. Check gauges and warning lights.	
3. Check horn, windshield wiper, washers, defrosters and controls		22. Check fluid, fan, shutter operation and service shutterstats.	
4. Check inside lights, buzzers, mirrors; check for loose screws, bolts, nuts on interior, damaged seat covers, paint.		23. Check strg. linkage, drag links tie-rod ends, king pins and tires.	
5. Check windows, seat anchors, frames, floor covering, fire extinguisher, doors and operation, stanchions		24. Check brake block, cam brg. and drums.	
6. Check heating and A/C controls, motors, circulating pumps, heater connections.		25. Check reservoir drain.	
7. Check for cleanliness of bus interior.		26. Check air compressor.	
8. Check instrument board.		27. Check trans. soft shift switch set at 900 RPM.	
9. Check destination sign.		28. Check axle flange bolts, troque wheels 500 ft. lbs.	
10. Check exterior lights.		29. Check differential lube, pinion seal and U joints.	
11. Check starter and solenoid switches.		30. Check anti-freeze in season.	
12. Check speedometer.		31. Complete lubrication job.	
13. Check brakes and adjust; lube cams, check condition and location of brake hose and lines.		32. Check transmission lube.	
		33. Check battery electrolite level	
14. Drain all air tanks, check operation of moisture inj. valve.		34. Check fan blades and fan hub bolts.	
15. Check water hoses and fan belts.		35. Check front wheel alignment.	
16. Check radiator surge tank.		36. Clean or replace heating and A/C filters.	
17. Check exhaust system, engine cradle and mounts.		37. Check air cleaner, record water column( ).	
18. Check suspension system, shocks, U-bolts, radius rods, bushings.		38. Check for leaks; oil, water, air and fuel.	
19. Check steering gear and axle steering EP-90.		39. Date of major interior cleaning.	

Record tire pressures: Inflate to 90 lbs. LF____ RF____ RRI____ RRO____ LRI____ LRO____

ROAD TEST BUS RECORD BODY DAMAGE_____

DATE BUS INSPECTED_____ FOREMAN_____

FLXIBLE AND GMC 4523A 12,000 MILE INSPECTION

	MECHANIC
1. Change transmission filters	
2. Change fuel filters	
3. Change engine oil by-pass filter	
4. Check and clean air filter	
5. Check door controls and lubricate linkage	

FLXIBLE AND GMC 4523A 36,000 MILE INSPECTION

1. Check starter, regulator and generator	
2. Check wheel bearing adjustments	
3. Check air compressor output	
4. Check toe-in and front wheel balance	
5. Check governor R. P. M.	
6. Change differential oil	
7. Change air cleaner and perry water filter	
8. Change transmission fluid	

LUBRICATE WHEEL STUDS AND INSPECT TREADS AT EACH WHEEL CHANGE.

REPACK WHEEL BEARINGS AT EACH BRAKE RELINE.

SET TOE-IN AND BALANCE FRONT WHEELS WHEN FRONT TIRES ARE CHANGED.

CHARLOTTESVILLE

Last Inspection Date:
2000_____
4000_____
8000_____

Vehicle #_____
Mileage_____
Date_____
Mechanic_____

2000 Mile Inspection

_____ Adjust Brakes (Including Parking Brake)
_____ Drain Air Tanks
_____ Grease All Fittings
_____ Check All Fluid Levels
Amounts Added:
Engine Oil_____Trans. Oil____Brake Fluid_____
Windshield Washer Fluid____Radiator Coolant_____
Coolant Protection____°F Power Steering Fluid____
A/C Oil_____Differential Oil_____
_____ Check for Leaks (Locate & Itemize)
_____ Check all Lights - repair as necessary
_____ Check Windshield Wipers - repair as necessary
_____ Check Steering - adjust for play
_____ Check all Suspension
_____ Check Exhaust System - repair immediately
_____ Check Spindles
_____ Check Tires (Pressure & Wear)
_____ Check all Belts & Hoses
_____ Check Battery- clean terminals
_____ Check Air Conditioning (Summer)
_____ Check Heating System (Winter)
_____ Check Horn Operation
_____ Check Mirrors & Glass Condition
_____ Check all Instrument Panel Gauges, Switches & Lights
_____ Check Door Operation
_____ Check Fire Ext. & First Aid Equip.

4000 Mile Inspection

In addition to the above:
_____ Change Engine Oil & Filters
_____ Change Fuel Filter(s)
_____ Change or Clean Air Filter
- steam clean engine.

8000 Mile Inspection

In addition to the above:
_____ Change Transmission Oil & Filter
_____ Change Differential Oil

TIME SPENT PERFORMING INSPECTION:_____

PARTS USED - INCLUDING FLUIDS

_____ _____
_____ _____
_____ _____
_____ _____
_____ _____
_____ _____
_____ _____
_____ _____
_____ _____
_____ _____
_____ _____
_____ _____

LIST ANY DEFECTS & REPORT ANY FAILING PART BELOW. LIST ITEMS REPAIRED DURING INSPEC.

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

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PETERSBURG AREA TRANSIT

BUS PREVENTIVE MAINTENANCE WORK SHEET

Date _____ Bus Number _____ Mileage _____

Chassis Lubrication Type of Work Freon Check

Mileage Inspection Change Transmission/Filters & Fluids Change Differential Oil

INSPECTION MILES _____ CHANGE OIL _____ CHANGE FILTERS _____ QTS. USED _____

TRANS. FILTER _____ QTS. USED _____ CHANGE FUEL FILTERS _____

1. TIRE PRESSURE _____
2. HORN _____
3. LIGHTING:
   A. HEAD _____ TAIL _____ LIC. _____
   B. MARKERS _____ STOP _____ DEST. _____
   C. DIRECTIONALS _____
   D. DOME _____ TELL TALE _____ HIGH BEAM IND. _____
4. BODY LEVEL _____
5. STEERING SHAFT _____ U-JOINTS _____ PLAY _____
   DRAG LINK _____ LINES _____ STEERING BOX _____ LEAKS _____
6. BRAKES:
   A. TRAVEL FRONT _____ REAR _____
   B. LINING FRONT _____ REAR _____
   C. ADJUST HAND BRAKE _____
7. DOORS:
   FRONT & REAR: A. CHECK MICRO SWITCH FOR STEP LITE _____
   B. AIR LINES _____
   C. DOOR CONTROL VALVE _____
   **Adjust if needed
8. AIR PRESSURE CUT-IN PSI (100-105) _____
   AIR PRESSURE CUT-OUT PSI (115-13-) _____
9. WINDSHIELD WIPERS & WASHER MIX _____
   A. MOTORS LEFT _____ RIGHT _____
   B. BLADES LEFT _____ RIGHT _____
   C. ARMS LEFT _____ RIGHT _____
10. DEFROSTER:
    A. OPERATION _____ CLEAN FILTER _____
11. PASSENGER CHIMES AND SWITCHES _____
12. ALARM SYSTEM:
    A. LOW AIR _____ B. LOW OIL _____ HOT ENG. _____
13. TAIL PIPE _____ MUFFLER _____ ENGINE UNDER FRAME _____
14. ENGINE SUPPORTS _____
15. ENGINE BLOWER DRAIN TUBES _____
16. DIFFERENTIAL: GREASE _____ VENT _____
17. PROP. SHAFT & U JOINTS _____
18. CHECK AIR FILTER, ENGINE _____
    **Replace Every 6 Months
19. CHECK BROKEN GLASS _____
20. CHECK TORN SEATS _____
21. RADIUS & LATERAL ROD BUSHINGS _____
22. STABILIZER BAR _____ BUSHINGS _____
    LINKS _____
23. SHOCK ABSORBERS _____
24. FUEL TANK CAP _____ LINES _____
25. BLOWER MOTORS:
    RANS _____ L. _____ R. _____
26. HEATER FILTER _____ CLEAN _____
27. HEATING COMP. DRAINS _____
28. DRAIN AIR TANKS _____
29. AIR PRESSURE REG. GRADUSTAT _____
30. COMPLETE CHASSIS LUB. _____
31. DIP STICK AND TUBE _____
32. TRANS. FLUID CHECK _____ ADD _____
33. ENGINE STOP CYL. _____
34. ENGINE EMCY. STOP _____
35. ACCELERATOR CONTROLS _____
    ACCELERATION INTERLOCK _____
36. ENGINE OIL LINES _____
37. FUEL LINES _____ PUMP _____ LEAKS _____
38. AIR LINES _____
39. AIR SAFETY CHECK VALVE _____
40. GENERATOR _____ OIL LEAKS _____
    CABLES _____ TERMS. _____ BOTTS _____
41. FAN & TORUS HOUSING _____
42. WATER PUMP _____ LEAK _____
43. TRANS. FLUID LINES _____
44. COOLING SYSTEM _____
    FILLER CAP _____ RADIATOR _____
    ALL WATER HOSE _____
    COOLANT LEVEL _____
45. BATTERIES _____ CABLES _____
    CARRIERS _____
    CLEAN _____
46. HEATER WATER PUMP _____
    ENG. COMPT. LIGHTS _____
    CHECK FOR FULL THROTTLE _____
47. LUB. DRIVER'S SEAT _____
48. FIRE EXTINGUISHER _____
49. CLEAN ALL AC FILTERS _____
50. CHECK FREON _____ ADD _____
51. CHECK WATER FILTER _____
    **Replace Every 6 Months

TIRES:	CONDITION:	PRESSURE:
L.F.	R.F.	
L.R.I.	R.R.I.	
L.R.O.	R.R.O.	

DETAILS OF OTHER WORK DONE:

COMPLETED INSPECTION DATE: _____ MECHANIC _____

SYMBOLS ✓ OKAY X WORK DONE O REPAIRS NEEDED

10-80

APPENDIX F

TRANSIT ONLY
MAINTENANCE INFORMATION FORMS

FORM 67-M 6-23-77

GREATER RICHMOND TRANSIT COMPANY
DAILY FUEL REPORT

Date_____

REGISTER NO._____ FINISH_____ START_____ USED_____

Bus No.	Gallons	Name	Bus No.	Gallons	Name	Bus No.	Gallons	Name	Bus No.	Gallons	Name	Bus No.	Gallons
31			263			408			522			629	
33			264			409			523			630	
34			265			410			524			701	
37			266			411			525			702	
201			267			412			526			703	
202			268			413			527			704	
203			269			414			528			705	
204			250			415			529			706	
205			251			416			530			707	
206			252			417			531			708	
207			253			418			532			709	
208			254			419			533			710	
209			255			420			534			711	
210			256			421			535			712	
211			257			422			536			713	
212			258			423			537			714	
213			259			424			538			715	
214			260			425			539			716	
215			261			426			601			717	
216			262			427			602			718	
217			263			428			603			719	
218			264			429			604			720	
219			265			430			605			721	
220			266			431			606			722	
221			267			432			607			723	
222			268			501			608			724	
223			269			502			609			725	
224			270			503			610			726	
225			271			504			611				
226			272			505			612				
227			318			506			613				
228			319			507			614				
229			321			508			615				
230			322			509			616				
231			323			510			617				
232			324			511			618				
233			325			512			619				
234			326			513			620				
235			327			514			621				
236			401			515			622				
237			402			516			623				
238			403			517			624				
239			404			518			625				
240			405			519			626				
241			406			520			627				
242			407			521			628				

Form 67-M2 4/20/76

GREATER RICHMOND TRANSIT COMPANY
DAILY OIL REPORT

Date_____

REGISTER NO._____ FINISH_____ START_____ USED_____

Bus No.	Oil Quarts	Name	Bus No.	Oil Quarts	Name	Bus No.	Oil Quarts	Name	Bus No.	Oil Quarts	Name	Bus No.	Oil Quarts	Name	Bus No.	Oil Quarts
31			237			305			350			504			605	
33			238			306			351			505			606	
34			239			307			352			506			607	
37			240			308			353			507			608	
201			241			309			356			508			609	
202			242			310			401			509			610	
203			243			311			402			510			611	
204			244			312			403			511			612	
205			245			313			404			512			613	
206			246			314			405			513			614	
207			247			315			406			514			615	
208			248			316			407			515			616	
209			249			317			408			516			617	
210			250			318			409			517			618	
211			251			321			410			518			619	
212			252			322			411			519			620	
213			253			323			412			520			621	
214			254			324			413			521			622	
215			255			325			414			522			623	
216			256			326			415			523			624	
217			257			327			416			524			625	
218			258			328			417			525			626	
219			259			329			418			526			627	
220			260			330			419			527			628	
221			261			331			420			528			629	
222			262			332			421			529			630	
223			263			333			422			530				
224			264			334			423			531				
225			265			335			424			532				
226			266			336			425			533				
227			267			337			426			534				
228			268			338			427			535				
229			269			339			428			536			C-5	
230			270			340			429			537			C-6	
231			271			341			430			538			C-8	
232			272			342			431			539			C-9	
233			301			343			432			601			C-315	
234			302			346			501			602				
235			303			348			502			603				
236			304			349			503			604				

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MATERIAL USED

QUANT.	PART NO.	DESCRIPTION OF PARTS	COST

FORM NO. 290 TOTAL MATERIAL COST

WORK ORDER

NO.

DETAIL	HRS.		TIME
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	

FORM JCF G-13 (R1)

REPORT OF OPERATIONS

DATE _____
WEATHER: A.M. _____
P.M. _____

DIVISION _____ DAY _____

TRANSPORTATION

SERVICE INTERRUPTIONS AND ROAD CALLS RESULTING IN PASSENGER DELAY

BUS NO.	TIME	ROUTE	CAUSE	DATE LAST INSP.	PSGR. DELD.	TIME DELD.	HOW HANDLED

ANNULMENTS AND LATE GARAGE DEPARTURES

RUN NO.	POINTS — BETWEEN	CAUSE

	TRANSIT A.M.	TRANSIT P.M.	INTER-CITY A.M.	INTER-CITY P.M.	PERSONNEL	REG.	EXT.	EXTRA BOARD		BUS HOURS		ACCIDENTS REPORTED	
Peak (sch.)					Vac.			Total		Lost		Coll.	
Actual					Sick			Available		Added		Psgr.	
Charter					Miss-Out			Used				Other	
Spare					Rep. Off			Used D - Off		BUS MILES		Empl.	
Shopped					Hires			Reg. on D - Off		Lost			
					Loss			Excused		Added			
TOTAL								R. D. Off					

TOTAL CHARTERS _____ OVERTIME
HRS. _____ MILES _____ Protection Time _____ Non-Scheduled O. T. _____

MAINTENANCE

PERSONNEL	INSPECTIONS	SHOP	ROAD SERVICE	OVERTIME WORKED
Vac. _____	Due _____	Over 2 days _____	Rep. on Rd. _____	Day Off _____
Sick _____			Change offs M. _____	
Miss-Out _____	Actual _____		Change offs O _____	Other _____
Rep. Off _____		Total 5 P.M. _____	Fare Boxes _____	
Hires _____	Defects _____		Other _____	TOTAL _____
Loss _____			Total Road Calls _____	

GENERAL REMARKS: _____ M. O. HRS. _____
W. A. HRS. _____

_____ for MAINTENANCE

_____ for TRANSPORTATION

JCF M-1 (R-1)

OPERATOR'S DEFECT REPORT

Each operator is required to report daily on this form over his signature the condition of this coach. State "O.K." or report defects and sign. Missing accessory equipment shall also be noted on this form. The absence of any notation shall indicate such equipment was on the coach and in good order when the coach was taken by the operator.

BUS NO. DATE

1. OPER. SIGN. OPER. No. Run No.

DEFECTS:

2. OPER. SIGN. OPER. No. Run No.

3. OPER. SIGN. OPER. No. Run No.

4. OPER. SIGN. OPER. No. Run No.

IF ADDITIONAL SPACE REQUIRED, USE REVERSE SIDE
MECHANIC RECORD REPAIRS ON REVERSE SIDE

ADDITIONAL SPACE FOR REPORT OF DEFECTS.

REPAIRS MADE:

MECHANIC'S SIGNATURE DATE

JCF M-12R-2

UNIT REMOVAL, REPAIR AND INSTALLATION

Name of Unit

Type | Unit No.

REMOVED	INSTALLED
Bus. No.	Bus. No.
Date	Date
Mileage	Mileage
Position	Position
By:	By:

Cause of Removal

Date Repairs Completed

Mechanic's Signature:

This portion of ticket must remain on Unit until installed, then send to office

Date | Unit No.

Name of Unit

From Bus No.

Position

Cause of Removal

Type

This portion of ticket must be detached and delivered to Office when Unit has been removed from bus

USED MATERIAL

REMOVED FROM BUS_____ DATE_____ 19____

MILEAGE_____ PART NO._____

DESCRIPTION_____

☐ To Be Reclaimed ☐ Test Material ☐ Return To Mfg. For Credit

PARTICIPATING CAMPAIGN ORDER NO. (IF ANY)_____

REMARKS:_____

_____

SIGNED_____

JCP M-4 (RX)

ROAD CALL REPORT

CALL RECEIVED BY:	DATE 19	TIME A.M. P.M.

BUS NO.	ROUTE	RUN OR BLOCK NO.

MEET AT:	TIME A.M. P.M.	DIRECTION

TROUBLE REPORTED

MECHANIC	LEFT GARAGE A.M. P.M.	ARR. AT BUS A.M. P.M.	BUS RELEASED A.M. P.M.	RET'D GARAGE A.M. P.M.

NO. PSSGRS. DELAYED	HOW MANY MIN.	WERE PSSGRS. TRSFD.

BUS REPAIRED ON ROAD TOWED IN CHANGED TO BUS NO.

TROUBLE FOUND:

REPAIRS MADE:

SIGNED

FOREMAN'S APPROVAL

9

RICHMOND

MAINTENANCE WORK OUTSTANDING DATE

Steam Clean	6000 Insp.	Clean Inside	Tire Shop	Reline	Shop	Shop	A/C	Swing Body	Misc.	Misc.
U	U	U	S	U	U	U	U	S	S	S
S	U	U	S	S	U	U	S	S	S	S
S	S	S	S	S	S	S	S	S	S	S
S	S	S	S	S	S	S	S	S	S	S
S	S	S	S	S	S	S	S	S	S	S
S	S	S	S	S	S	S	S	S	S	S
S	S	S	S	S	S	S	S	S	S	S
S	S	S	S	S	S	S	S	S	S	S

HOLD IN SHOP

Bus No. AM PM	Days in shop	Trouble Reported	Comp By	Date
1				
2				
3				
4				
5				
6				
7				
8				
9				
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
0				
1				
2				
3				
4				
5				

Remarks:

67-NO-1
2-6-80

TIDEWATER REGIONAL TRANSIT

DAILY DIESEL FUEL AND OIL REPORT

(Report Fuel in "Gallons" & Oil in "Quarts")

Date _____

DIESEL PUMP NO. 1	DIESEL PUMP NO. 2	DIESEL PUMP NO. 3	DIESEL PUMP NO. 4	TOTAL FUEL
Finish				
Start				
Used				

BUS NO.	FUEL, OIL, NAME	BUS NO.	FUEL, OIL, NAME	BUS NO.	FUEL, OIL, NAME	BUS NO.	FUEL, OIL, NAME	BUS NO.	FUEL, OIL, NAME	BUS NO.	FUEL, OIL, NAME
101		225		315		401		434		467	
102		226		316		402		435		468	
103		227		317		403		436		469	
104		228		318		404		437		470	
105		229		319		405		438		471	
106		230		320		406		439		472	
107		231		321		407		440		473	
108		232		322		408		441		474	
109		233		323		409		442		501	
110		241		324		410		443		502	
201		242		325		411		444		503	
202		243		326		412		445		504	
203		244		327		413		446		505	
205		245		328		414		447		506	
206		246		329		415		448		507	
207		248		330		416		449		508	
208		251		331		417		450		509	
209		253		332		418		451		510	
210		254		333		419		452		511	
211		301		334		420		453		512	
212		302		335		421		454		513	
213		303		336		422		455		514	
214		304		337		423		456		515	
215		305		338		424		457		516	
216		306		339		425		458		517	
217		307		340		426		459		518	
218		308		341		427		460		519	
219		309		342		428		461		520	
220		310		343		429		462			
221		311		344		430		463			
222		312		345		431		464			
223		313		346		432		465			
224		314		347		433		466			

JCP M-1 (R-1)

OPERATOR'S DEFECT REPORT

Each operator is required to report daily on this form over his signature the condition of this coach. State "O.K." or report defects and sign. Missing accessory equipment shall also be noted on this form. The absence of any notation shall indicate such equipment was on the coach and in good order when the coach was taken by the operator.

BUS NO. DATE

1. OPER. SIGN. OPER. No. Run No.

DEFECTS:

2. OPER. SIGN. OPER. No. Run No.

3. OPER. SIGN. OPER. No. Run No.

4. OPER. SIGN. OPER. No. Run No.

IF ADDITIONAL SPACE REQUIRED, USE REVERSE SIDE
MECHANIC RECORD REPAIRS ON REVERSE SIDE

ADDITIONAL SPACE FOR REPORT OF DEFECTS:

REPAIRS MADE:

MECHANIC'S SIGNATURE DATE

JCP M-4 (R1)

ROAD CALL REPORT

CALL RECEIVED BY:	DATE T9	TIME A.M. P.M.
BUS NO.	ROUTE	RUN OR BLOCK NO.
MEET AT:	TIME A.M. P.M.	DIRECTION

TROUBLE REPORTED

MECHANIC	LEFT GARAGE A.M. P.M.	ARR. AT BUS A.M. P.M.	BUS RELEASED A.M. P.M.	RET'D GARAGE A.M. P.M.

NO. PSSGRS. DELAYED	HOW MANY MIN.	WERE PSSGRS. TRSFD.

BUS REPAIRED ON ROAD | TOWED IN | CHANGED TO BUS NO.

TROUBLE FOUND:

REPAIRS MADE:

SIGNED

FOREMAN'S APPROVAL

19

WORK ORDER

NO

DETAIL	HRS.		TIME
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	

MATERIAL USED

QUANT.	PART NO.	DESCRIPTION OF PARTS	COST

Form No. 290 TOTAL MATERIAL COST

9-16-68

INSPECTION SCHEDULE
BUSES, AUTOMOBILES & TRUCKS

Norfolk, Virginia

Date_____

Day Shift

Dead: 7:00 A.M._____

Trippers_____

Trippers_____

Trippers_____

Trippers_____

Trippers_____

Steam Cleaning

Job No.	Bus No.
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	(Clean-up)

Lubrication
Oil Change Only_____

6,000 Mile Inspection
Lubrication and Oil Change

7:00 A.M. to 3:30 P.M.

7:00 A.M.

Job No.	Vehicle Numbers
1.	
2.	
3.	

11:00 A.M.

4. _____

5. _____

6. _____

Night Shift - Auto/Truck
Inspection, Lubrication
and Oil Change

1. _____

2. _____

Signed_____

SHEET NUMBER

DATE:

BUS NO	GAL FUEL	QTS OIL	BUS NO	GAL FUEL	QTS OIL	BUS NO	GAL FUEL	QTS OIL	BUS NO	GAL FUEL	QTS OIL
211			606			640			673		
212			607			641			674		
213			608			642			675		
214			609						676		
215			610			643			677		
216			611			644			678		
217			612			645			679		
218			613			646			680		
219			614			647			681		
220			615			648			682		
221			616			649					
222			617			650			100		
223			618			651			101		
224			619			652			102		
225			620			653			103		
226			621			654			104		
227			622			655			105		
228			623			656			106		
229			624			657			107		
230			625			658			700		
231			626			659			701		
232			627			660			702		
233			628			661			703		
234			629			662			704		
235			630			663			705		
236			631			664			730		
87			632			665			731		
			633			666			732		
600			634			667			733		
601			635			668			734		
602			636			669			735		
603			637			670			736		
604			638			671					
605			639			672					

Leave this DAILY OPERATION CARD in Bus

Inspected for Minor Defects by _____ Bus No. _____

Tanks Drained by _____ Date _____ 19

Operators Mark Badge Number in front of all items needing attention, or in OK Column

Badge No	ITEM	Mech. No.	Time
	EQUIPMENT		
	Fire Extinguisher		
	Flares		
	Horn		
	Windshield Wiper		
	Outside Mirror		
	Inside Mirrors		
	ENGINE		
	No Power		
	Knocks		
	Misses		
	Stalls		
	Heats		
	Backfires		
	Oil Leaks		
	Exhaust Leaks		
	Vibration		
	RADIATOR		
	Leaks		
	Bolts		
	Cap		
	Fan Belt		
	STEERING GEAR		
	Loose		
	Tight		
	Shimmies		
	HAND BRAKES		
	Loose		
	Tight		
	Locks		
	Squeals		
	FOOT AIR BRAKES		
	Loose		
	Tight		
	Locks		
	Slump		
	Pressure		
	CLUTCH		
	Slips		
	Drags		
	GEAR SHIFT		
	Hard		
	Grinds		
	Sticks		
	TRANSMISSION		
	DRIVE SHAFT		
	REAR AXLE		
	MUFFLER		
	Torque Converter		
	Accident (Yes)		
	Accident (No)		

Badge No.	ITEM	Mech. No.	Time
	LIGHTS		
	Dome		
	Head		
	Tail		
	Stop		
	Step		
	Sign		
	Signal		
	Marker		
	Tail Pipe		
	IGNITION		
	Generator		
	Distributor		
	Starter		
	Battery		
	Instrument Board		
	GAS SYSTEM		
	Leaks		
	Fumes		
	Clogged		
	SPRINGS		
	Front		
	Rear		
	BODY		
	Buzzers		
	Bumpers		
	Entrance Door		
	Exit Door		
	Fenders		
	Heaters		
	Panels		
	Seats		
	Signs		
	Directional Signals		
	Windows		
	Windshield		
	Cash Register		
	Transfer Register		
	TIRES		
	Wheels Loose		
	Damaged		
	Soft		
	Flat		
	Hub Stud		
	1. Bus OK		
	2. Bus OK		
	3. Bus OK		
	4. Bus OK		

OPERATORS MUST SIGN BELOW

	Badge No.
1.	1.
2.	2.
3.	3.
4.	4.

Remarks:

OK'ed by _____

Foreman

201

FARE BOX TROUBLE CARD

GENERAL FAULT

Dead	___	Hangs	___	Other (Describe)	
Will Not Pwr-up	___	Powers Own	___	_____	
Will Not Run	___	Will Not Pow Own	___	_____	
				_____	

SPECIFIC FAULT

Data Display	___	Dump Door	___	Rte Run	___
Driver Display	___	Switch Panel	___	Data Plug	___
Coin Motor	___	Fare Switch	___		
Bill Motor	___	Dump Switch	___		
Beeper	___	Index Switch	___		

Can problem be duplicated ? Yes ___ No ___

Description of Problem _____

_____

_____

SERVICE USE - DO NOT WRITE BELOW THIS LINE

LOCATION - SERVICE REPORT

PTDC NO. _____

FAREBOX S/N _____

CHASSIS S/N _____

Can problem be duplicated? Yes ___ No ___

Description of Problem _____

_____

_____

Corrective Action _____

_____

_____

Mods performed _____

_____

Date_____ Signature:

Technician _____

Supervisor _____

General Foreman_____
Supt. of Maint._____
Asst, Gen. Mgr._____
for Operations
Operations File_____

PENINSULA TRANSPORTATION DISTRICT COMMISSION

MAINTENANCE DEPARTMENT
DAILY STATISTICAL REPORT

DAY_____ DATE_____

SUMMARY OF WORK PERFORMED

BO's Worked	TOTAL_____	D_____	A_____	BO's Remaining_____
Road Calls	TOTAL_____	D_____	A_____	
Towed In	TOTAL_____	D_____	A_____	
Buses Fueled & Serviced	TOTAL_____	D_____	A_____	
Washers Working		D yes/no	A yes/no	
Buses Shopped & Waiting	TOTAL_____	Over 30____	Over 60____	Over 90____
Inspections Performed (6,000 miles)	TOTAL_____	D_____	A_____	Remaining_____
Interior Cleaning	TOTAL_____	D_____	A_____	Remaining_____
Air Conditioning	TOTAL SERVICED_____	OPERATING_____	NOT OPERATING_____	

TRIPPED

Body_____ Minor Mech._____ Tires_____ P.M._____ TOTAL_____

Comments: _____

_____

_____

ASSIGNED PERSONNEL TOTAL_____ D_____ A_____ Midnight_____

Vacation_____	Off Excused_____	Suspension_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
Sick_____	Reported Late_____	O.T. Hours_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

PENTRAN FORM 321 REV. 3/79

Gen. Foreman _____
Supt. Maint. _____
A.G.M.-Oper. _____
A.G.M.-Market _____
Gen. Manager _____
Operations
File

FORM 2 PENINSULA TRANSPORTATION DISTRICT COMMISSION

MAINTENANCE DEPT.

DAILY REPORT OF COACHES OUT OF SERVICE

BUS NO.	REASON	DATE	BUS NO.	REASON	DATE

(S-SCHEDULED OUT W-WORKING)

SUMMARY

IN SERVICE ___ RUNS _____

SHOPPED _____

SPARES _____

STORAGE _____

TOTAL _____

SUBJECT: DAILY MAINTENANCE FAILURES

DIRECTOR OF SERVICES

BUS NO.	TROUBLE LOCATION	TROUBLE REPORTED	TROUBLE FOUND	NO. PASS.	TIME ON	TIME OFF

Peninsula Transportation District Commission
3400 Victoria Boulevard
Hampton, Virginia 23661

Nº

WORK ORDER

NAME _____ DATE PUT IN SHOP _____

VEHICLE NUMBER _____ DATE WORK COMPLETED _____

DESCRIPTION OF VEHICLE _____ DATE PICKED UP _____

SPEEDOMETER READING _____ RECEIVED BY _____

DESCRIPTION OF WORK			QTY/HRS	AMOUNT
	FUEL	F		
	TOWING SERVICE	T		
	GEAR OIL	G		
	A T F FLUID	A		
	MOTOR OIL	O		
	LABOR	L		
	MATERIAL	M		
Assigned to: Name _____	OUTSIDE CONTACT SERVICES _____	C		
Authorized By: Supervisor's Name _____	TOTAL			

PENTRAN FORM 328

LABOR

DATE	MECHANIC-SERVICEMAN	WORK DONE	AMOUNT	HOURS	TIME																				
					IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	TOTAL

GREATER ROANOKE TRANSIT COMPANY DATE_____

DIESEL RESERVE	DIESEL	OIL
Beg. Balance_____	Beg. Balance_____	Beg. Balance_____
Purchases**_____	Purchases**_____	Purchases**_____
Issues_____	Issues_____	Issues_____
Closing Bal._____	Closing Bal._____	Closing Bal._____
Phy.(Stick) Read._____	Phy.(Stick) Read._____	Phy.(Stick) Read._____
Over or Short_____	Over or Short_____	Over or Short_____
End. Meter Read._____	End. Meter Read._____	End. Meter Read._____
Beg. Meter Read._____	Beg. Meter Read._____	Beg. Meter Read._____
TOTAL ISSUES_____	TOTAL ISSUES_____	TOTAL ISSUES_____

BUS NO.	GAS	DIESEL	OIL	BUS NO.	GAS	DIESEL	OIL	BUS NO.	GAS	DIESEL
13				172				184		
161				173				185		
162				174				186		
163				175				187		
164				176				188		
165				177				189		
166				178				190		
167				179				191		
168				180				192		
169				181				193		
170				182				194		
171				183				195		

#1 Diesel Stick Reading

Inches ____ -_____

Inches ____ -_____

Total -_____

2 - 3,000 Tanks

#2 Diesel Stick Reading

Inches ____ -_____

Inches ____ -_____

Total -_____

2 - 6,000 Tanks

Oil Stick Reading
Last Day of Month

1 - 6,000 Tank

Inches ____

Total _____

Date _____

Greater Roanoke Transit Co.

DAILY WORK SCHEDULE

Date: ______________________

PM	Unit #	Date O/S	Work Required	Order #	Mechanic	Date I/S

Hold For Tomorrow

Valley Metro

OPERATOR'S DAILY REPORT OF CONDITION OF VEHICLE

All defects must be noted on this card.
If no defects, mark card OK.

Bus No.

Date ..... 19.....

	OPERATOR	Badge No.	Time On		OPERATOR	Badge No.	Time On
1st			M	3rd			M
2nd			M	4th			M

1st OPERATOR'S REMARKS	3rd OPERATOR'S REMARKS

2nd OPERATOR'S REMARKS	4th OPERATOR'S REMARKS

GARAGE AND SHOPMEN'S REMARK

If repairs are made by shopmen, they must be listed below:

Repairs Made	Name
Oil	
Converter Fluid	
Lights	
Emergency Brakes	
Other Repairs Made	

Report Examined

....., 19.....

.....

Garage Foreman

REPAIR ORDER

No 1463

Speedometer reading _____ Date _____ Vehicle No. _____

Description of work	Mech. Number	Time Worked

Part Number	Description	Min.	Qty.	Unit Price		Extension	

Code	Emp. No.	Clock	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
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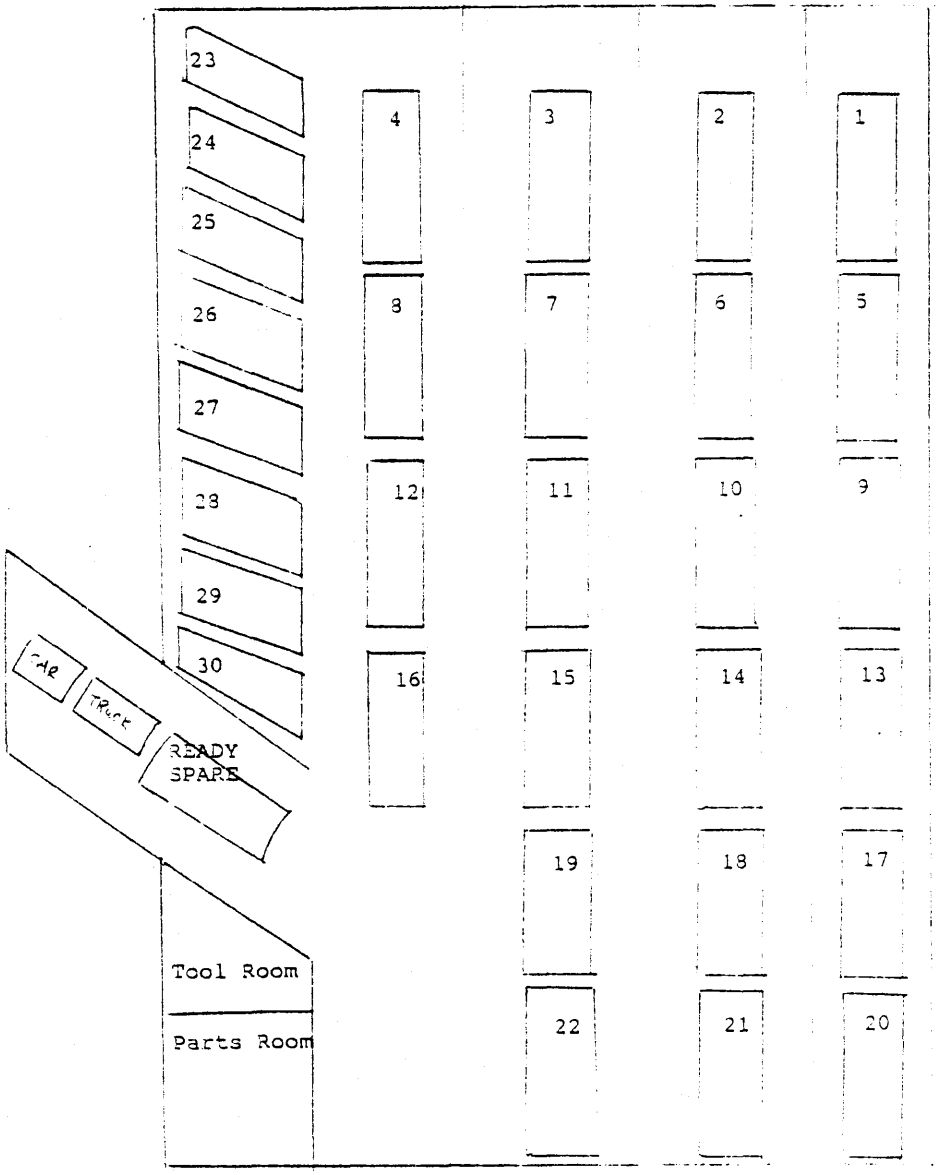
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	

ROANOKE

BUS READY LINE DISPATCH SHEET - WORK SHEET



Date: _____

Day: _____

Fore-man: _____

Instructions: Night foreman to show where each bus is parked, as well as restrictions on bus use, if any, and also to show work held over, if any. All buses are to be accounted for on this sheet in some fashion or another.

Note: typed no. is the sequence for morning departure. Sheet should be given dispatcher in the a.m. before first bus departs.

ON CHART... Circle bus nos. in place but not to be used.

Buses parked across street: _____

Buses parked in body shop: _____

Buses out of service today, and why: _____

_____

_____

_____

For use on short runs only: _____

Spare Buses: _____

GREATER ROANOKE TRANSIT COMPANY

FLEET PERFORMANCE REPORT

Month of _____

Number of Buses	Description	Miles	Gallons of Fuel	Miles per Gallon of Fuel	Quarts Oil Added	Miles Per Quart Oil Added
22	FLX 4509-6 1976 161 - 182					
13	FLX 870-6 1979 183 - 195					
35	Total					

JCF M-4 (R1)

ROAD CALL REPORT

CALL RECEIVED BY:	DATE 19	REC. TIME A.M. P.M.

BUS NO.	ROUTE	BADGE & BLOCK NO.

MEET AT:	MEET TIME A.M. P.M.	DIRECTION

TROUBLE REPORTED

MECHANIC	MISSED TRIPS	CHANGED TO BUS NO.

NO. PSSGRS. DELAYED	HOW MANY MIN.	WERE PSSGRS. TRSFD.

BUS REPAIRED ON ROAD TOWED IN

TROUBLE FOUND:

REPAIRS MADE:

MECHANIC'S SIGNATURE

FOREMAN'S APPROVAL

GREATER LYNCHBURG TRANSIT COMPANY
DAILY FUEL AND OIL REPORT

DATE

BUS NUMBER	DIESEL FUEL	MOTOR OIL	BUS NUMBER	DIESEL FUEL	MOTOR OIL
561			616		
562			700		
563			701		
564			702		
565			703		
566			#1 OIL PUMP		
600			End. Meter Reading		
601			Beg. Meter Reading		
602			Total Issues		
603			#2 OIL PUMP		
604			End. Meter Reading		
605			Beg. Meter Reading		
606			Total Issues		
607			#3 OIL PUMP		
608			End. Meter Reading		
609			Beg. Meter Reading		
610			Total Issues		
611					
612			DIESEL FUEL READING		
613			END. METER READING		
614			BEG. METER READING		
615			TOTAL ISSUES		

DATE _____ COACH NO. _____

Daily Service Card

A. M. REPORT

NAME OF OPERATOR

P. M. REPORT

NAME OF OPERATOR

EACH OPERATOR MUST MAKE HIS OWN REPORT

REPAIR ORDER

DATE BUS NO.

DESCRIPTION OF REPAIRS NEEDED	HRS.		TIME
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	
		IN	
		OUT	

MECHANIC ____________ DATE ____________ FOREMAN ____________

MATERIAL USED

QUANT.	PART NO.	DESCRIPTION OF PARTS	COST

Form No. 290 TOTAL MATERIAL COST

GREATER LYNCHBURG TRANSIT CO.

WEEKLY INSPECTION

BUS #_____ DATE_____

BODY DAMAGE: LIST ALL, INCLUDING SEATS AND BUMPERS_____

_____

_____

_____

CONDITION OF INTERIOR:

CLEAN_____ DIRTY_____

TRANSMISSION: FULL YES_____ NO_____ NO. QTS. ADDED_____

CHECK FOR LEAKS

OIL FULL YES_____ NO_____ NO. QTS. ADDED_____

CHECK FOR LEAKS

WATER FULL YES_____ NO_____ AMOUNT ADDED_____

CHECK FOR LEAKS

CHECK ANTIFREEZE IN WINTER PROTECTED TO + _____ ° - _____ °

LIGHTS: O.K._____ NO. OF LIGHTS OUT _____

BRAKES: ADJUST ALL CHECK CLEARANCE BETWEEN SHOES AND DRUM. MUST BE FREE

LIST CONDITION OF:

LINING Good_____ Fair_____ Need Replacing _____

DRUMS Good_____ Fair_____ Need Turning_____ Need Replaced_____

HOSES Good_____ Fair_____ Need Replacing_____

BATTERIES:

CHECK SPECIFIC GRAVITY. REPLACE ANY BELOW 1250, OR IF CELLS SHOW WEAK.
USE GOOD FULLY CHARGED BATTERY BEFORE YSING NEW ONE.

_____
MECHANIC SIGNATURE

Greater Lynchburg Transit Co.

ROAD CALL REPORT

Date of Incident _____ Time _____ M

Location of Incident _____ Direction of Bus _____

Bus No. _____ Route _____ Operator _____

Trouble Reported: _____

Time Shop Arrived on Scene: _____

Trouble Found: _____

Date Corrected: _____

Other Information: _____

Signed _____

CHARLOTTESVILLE

Page No. ____

Date _____

Vehicle Number	Mileage	Fuel Code	Gallons	Quarts (Oil)	Driver's Signature
		Control total			
		Keypunch total			

Fuel Codes: Regular = 1
Unleaded Regular = 2
Ethyl = 3
Diesel = 4

	Regular	Unleaded	Ethyl	Diesel	
PM Reading					
AM Reading					Pumps Total
Totals					

CHARLOTTESVILLE

DAILY VEHICLE CHECKLIST

DATE_____ VEHICLE #_____

A.M. SHIFT_____

P.M. SHIFT_____

MILEAGE ON_____ MILEAGE OFF_____

	INSPECT ITEM'S BELOW ✓ CHECK IF O.K.	NOTE DEFECTS BELOW
1.	EXTERIOR	
	TIRES_____	_____
	TURN SIGNALS_____	_____
	HEAD LIGHTS_____	_____
	TAIL LIGHTS_____	_____
	WINDSHIELD WIPERS_____	_____
	FRESH BODY DAMAGE_____	_____
2.	INTERIOR	
	BRAKES_____	_____
	STEERING_____	_____
	DASH GAUGES_____	_____
	RADIO_____	_____
	FRESH DAMAGE_____	_____
3.	HOOD	
	OIL LEVEL_____	_____
	RADIATOR LEVEL_____	_____
	BATTERY LEVEL_____	_____

DRIVER_____ MECHANIC_____

CHARLOTTESVILLE

DAILY STATUS SHEET

DATE _____

BUS	
804	
805	
806	
807	
808	
809	
810	
811	
812	
813	
814	
815	
816	
817	

PETERSBURG AREA TRANSIT

MILEAGE—GAS—OIL—SUMMARY

DATE _____

BUS NO.	MILES	DIESEL	OIL	TRANS.	PTO FLUID	BUS NO.	MILES	GAS	TRANS.
60						52			
61						53			
62						56			
63						57			
64									
65									
66						TOTAL			
67									
68									
69									
TOTAL									

METER READINGS

CLOSING _____

OPENING _____

TOTAL USED _____

PETERSBURG AREA TRANSIT

WORK ORDER

Date _____ Bus No. _____

No. Parts	DESCRIPTION OF WORK DONE	Parts Cost

WORK DONE BY: _____ APPROVED BY: _____

ROAD CALL REPORT

Date: _____ Time Called _____

Operator _____

Bus No. _____

Line _____

Trouble Reported _____

_____

_____

Parked At: _____

_____

Meet At: _____

_____

Time Due: _____

Received By: _____

Bus Out _____ Bus In _____

Time Out _____ Time In _____

Call Made By _____

Remarks as to Repair in Shop _____

_____

_____

_____

_____

_____

(Turn in to Office Daily)

TRI-CITY COACHES, Inc.

Trouble Report

DATE _____ Bus. No. _____

OPERATOR _____

CHECK AND EXPLAIN BELOW

BRAKES _____ STEERING _____

DOORS _____ TIRES _____

LIGHTS _____ WHEELS _____

MOTOR _____ BODY _____

SEATS _____ WINDOWS _____

FAREBOX _____ OTHER _____

EXPLANATION

USE BACK IF NEEDED