

MICHIGAN DEPARTMENT OF TRANSPORTATION

OFFICE OF PASSENGER TRANSPORTATION

PREVENTIVE MAINTENANCE MANUAL

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INTRODUCTION

Transit agencies (TA) are required by contract to maintain vehicles throughout their useful life. This maintenance must conform to at least the manufacturer's minimum recommended service levels.

TA are required to submit a written vehicle maintenance plan to the Michigan Department of Transportation (MDOT), Office of Passenger Transportation (OPT) for review and approval. Any subsequent additions or changes must also be approved before they become effective. A sample maintenance plan is included in this guidance document as Exhibit 1.

The OPT compliance analyst (CA) will conduct an onsite review of each TA vehicle maintenance program on a triennial basis. The review consists of a random sampling (20 percent of the fleet or a maximum of 10 vehicles) of vehicle maintenance records for compliance with the approved plan. If any discrepancies are found, follow-up reviews will be conducted at least annually until the TA is brought into compliance through a written and approved corrective action plan. Three consecutive deficient reviews will result in withholding of 25 percent of the TA operating funds and/or award of project authorizations and require a minimum of two unannounced maintenance records reviews before full funding is reinstated.

The purpose of this manual is to provide information for a successful maintenance program and to assist the TA in the creation and implementation of a vehicle maintenance plan.

The following list represents components of an effective and compliant maintenance plan.

REQUIRED COMPONENTS

- Maintenance Policy Statement
- Daily Inspections
- Safety Inspections
- Routine Service and Maintenance Schedule
- Record Keeping

OTHER COMPONENTS

- Diagnostics
- Repair Control
- Parts Procurement and Inventory
- Warranty Coverages
- Performance Management
- Training
- Cooperation and Interaction

MAINTENANCE POLICY STATEMENT

A maintenance policy directs decision making toward achieving maintenance objectives and enables the TA to run their program in an efficient and effective manner. A TA manager should review maintenance information with a methodical approach and an eye toward making improvements.

Maintenance planning reduces the uncertainty involved in decision making and provides program consistency. Planning also helps the TA focus on achieving their vehicle maintenance objectives. By understanding the TA's desired course, management can create a control structure to determine whether the TA is *on* the desired course.

At a minimum, the TA maintenance policy statement must summarize their maintenance program including all required components and how these help them achieve the desired vehicle maintenance objectives.

DAILY INSPECTIONS

Daily inspections performed by either the driver or the mechanic are a key element to the early detection and remedy of potential failures. Spending a few minutes every day conducting the pre-trip inspection on each vehicle will help detect problems, improve safety, and decrease vehicle repair costs.

At a minimum, a vehicle pre-trip inspection must be performed every time a vehicle is to be used.

A sample pre-trip inspection form is included in this guidance document as Exhibit 2.

SAFETY INSPECTIONS

Scheduling routine safety inspections are also a key element to the early detection and remedy of potential safety-related failures. As the age of the vehicle increases, the TA manager may want to schedule the safety inspections more often.

At a minimum, mechanics should perform vehicle safety inspections every six months, emphasizing everything affecting safe vehicle operation. If a TA contracts for maintenance, the inspection must be conducted by a mechanic certified for that class of vehicle.

The maintenance plan must include the methodology and the process your agency uses to determine when to schedule a vehicle for a safety inspection so that pre-established time limits are not exceeded. This methodology should include the staff positions that will be involved and the data/documents used. The plan should also include the process your agency uses to verify that all vehicles have been inspected prior to exceeding the deadline. This

verification process should also include the staff positions that will be involved and the data/documents used.

A sample vehicle safety inspection form is included in this guidance document as Exhibit 3.

ROUTINE SERVICE AND MAINTENANCE

Preventive maintenance is an essential element of every effective vehicle maintenance program. It helps to ensure maximum vehicle reliability, safety, and longevity. Preventive maintenance involves performing regularly scheduled maintenance services, adjustments, and inspections based on a predetermined interval of months, miles, or hours operated to minimize malfunctions. Maintenance intervals should never exceed those recommended by the manufacturer. It also involves performing necessary repairs promptly to prevent further damage and to ensure vehicle safety. Proactive vehicle maintenance versus reactive vehicle maintenance should be a goal of every successful vehicle maintenance program.

For a maintenance program to be most effective, it must be designed around each specific vehicle, fit the vehicle's operating conditions, and change when the vehicle or operating conditions change.

At a minimum, the TA must provide a basic maintenance schedule which conforms with the minimum manufacturer recommendations for the following categories:

- engine oil and filter
- chassis lubrication
- air filter
- fuel filter (if equipped)
- wheelchair lift and securement
- vehicle cleaning
- disc and drum brakes
- transmission
- drive axle
- engine cooling system
- air conditioning
- safety inspections (minimum every 6 months)

The maintenance plan must include the methodology and the process your agency uses to determine when to schedule a vehicle for routine services so that pre-established intervals are not exceeded. This methodology should include the staff positions that will be involved and the data/documents used. The plan should also include the process your agency uses to verify that all vehicles have been serviced prior to exceeding the intervals. This verification process should also include the staff positions that will be involved and the data/documents used.

A sample basic maintenance schedule is included in this guidance document as Exhibit 4.

RECORD KEEPING

All vehicle maintenance should be documented in the vehicle's historical record. This information can be analyzed to identify trends and diagnose equipment repairs. The recommended way to maintain vehicle histories is to place important forms (inspections, receipts, work orders, etc.) in separate folders for each vehicle. Using accurate and timely information, the maintenance manager can make changes to improve performance.

At a minimum, the TA must maintain adequate vehicle maintenance historical records to substantiate that maintenance is being performed to manufacturer recommendations for the required categories. The transit manager needs to assure that the work is being performed at the correct service intervals. In addition, the TA vehicle records must substantiate that both daily inspections and safety inspections are being performed.

DIAGNOSTIC

Diagnostic work helps identify potential failures before they occur. The following are several ways it can be applied.

- Early detection – longer major component life can be obtained by early detection of minor problems that could lead to premature failures.
- Component replacement – by reviewing records, the anticipated failure points can be developed on some components. Replacing these components prior to their expected failure can reduce road calls and unscheduled repairs.
- Diagnostic equipment – proper test equipment is another way of diagnosing problems.
- Failure analysis – finding the cause of a failure is a critical step in preventing a recurrence. Mechanics must be more than “parts changers” – they need to look for the initial cause, so it doesn't happen again.
- Logical inspections – a logical sequence will reduce inspection time and vehicle down time. In a logical sequence, an inspector does everything possible prior to moving to another area.
- Preventive maintenance repairs – the preventive maintenance inspection consists of inspecting, servicing, adjusting, and performing minor repairs. It is not advisable to perform major repairs during the actual preventive maintenance inspection if the repair requires a changeable part or will take more than 15 minutes. All safety related items should be repaired prior to placing the vehicle back in service.

REPAIR CONTROL

Once a vehicle is identified as needing maintenance work, it's important that the work be tracked and scheduled so repairs do not go unchecked, duplicate work is not performed, and work is completed in the most efficient manner. Work orders are the most efficient way to record and track work. Once a work order is prepared, it usually falls into one of these categories.

- In work – as the vehicle, manpower, work space, and parts become available, the mechanic takes the work order and begins the work.
- Awaiting maintenance – all work orders that are ready.
- Deferred – if a repair is deferred, it's decided that the vehicle is workable and the defects can be postponed with no further deterioration or safety risk.

PARTS PROCUREMENT AND INVENTORY

Parts availability is important to the planning and efficiency of the vehicle maintenance operation. Necessary vehicle repair work cannot be completed if the parts are unavailable. A parts inventory represents a sizable investment of public funds. Procedures to safeguard this investment and to ensure the mechanic can find a required part when needed are as follows.

- Organization of the parts storage room – organized parts by the type of vehicle and function,
- Stock issuance – when drawing parts from the storage room, record in inventory the part number, part name, quantity drawn from stock, date, and vehicle number the part was issued to. The balance on hand will reflect changes to the inventory that can be tracked.
- Ordering and receiving stock – order new stock when on hand drops below a predetermined quantity. Consider lead time required for receipt of new stock. Use past orders to get an indication of how long it will take for delivery.
- Smart purchasing – TA have several options to reduce maintenance and supply costs.
- Reduce the number of high dollar parts in stock. Inventory costs money. Don't take the risk of buying an expensive part you may never use.
- TA can develop alternate part numbers and sources. Always have backup sources for the most commonly used parts.

PERFORMANCE MANAGEMENT

The TA maintenance manager has two primary concerns when developing performance indicators. First, indicators are needed that management can use to evaluate the maintenance department's overall performance. Second, indicators are needed that can be used to monitor the maintenance department's internal performance. Indicators should help the maintenance manager evaluate internal productivity and develop management principles.

Consider the following when establishing performance indicators:

- Fleet reliability indicators
- Miles per road call
- Road calls per bus per month
- Fleet maintenance indicators
- Cost per vehicle mile
- Cost per vehicle
- Labor cost per vehicle
- Labor cost per vehicle hour
- Fuel – average miles per gallon
- Oil – average miles per quart
- Fleet availability indicators
- Number of “open” work orders
- Average number of maintenance jobs in the backlog
- Average duration of “open” work orders
- Work quality indicators
- Number of repeat repairs per month
- Total labor hours spent on preventive maintenance vs. total labor hours
- Work productivity indicators
- Total regular and overtime maintenance hours per month
- Average labor time to perform each type of preventive maintenance inspection
- Maintenance manager control indicators
- Total preventive maintenance inspections scheduled per month vs. inspections performed
- The average miles past the scheduled interval past preventive maintenance inspections

WARRANTIES

A warranty is a manufacturer’s assurance that a product will perform properly for a specific time or usage level. If the product fails to meet this assurance, the manufacturer is obligated to make restitution. This restitution usually consists of one or a combination of the following:

- Replace the defective item
- Repair the defective item
- Reimbursement for cost of having item repaired
- Furnish a replacement part

The primary importance of a warranty program is that it partially offsets the cost to maintain a vehicle. Warranties cover new vehicles, many new/replacement parts, and most vendors’ work. Any compensation from the manufacturer for costs incurred saves the TA money. A warranty program is also an opportunity to provide feedback to the manufacturer concerning

their product. Most manufacturers rely heavily on this information when considering product improvements.

All new vehicles have warranties that, at a minimum, cover labor and replacement parts for a specific number of miles or period.

Warranty information is provided with the delivery of a new vehicle. For specific warranty related questions, the TA should contact the vendor/manufacturer.

Most vehicles are not perfect at delivery and vehicle manufacturers expect adjustments will be needed. Prior to starting repairs, the TA should contact the vendor/manufacturer to determine if the repairs are warranty related. If repairs are warranty related, follow procedures as defined by the vendor/manufacturer and obtain their approval prior to beginning warranty repairs.

The following are primary reasons many TA do not receive the maximum benefit from a warranty program:

- Warranty coverage is not fully understood and never submitted as a claim.
- Repair work is performed before it is determined if the failure is warranty related.
- Information for warranty claim is lost (what failed, why, when, lost parts, etc.)
- Failed parts cannot be matched with warranty claim.
- Warranty claim not submitted within specified time.
- Apathy (people don't understand the importance of a warranty).

TRAINING

Effective training is essential to the proper diagnosis of vehicle problems and their subsequent repair/replacement. As vehicles become increasingly complex and reliant upon electronic and computerized controls and monitoring systems, the need for adequate training becomes that much more important.

We suggest encouraging, or even requiring, your mechanic to take advantage of the training offered by vehicle manufacturers and component suppliers. Some manufacturers run regional training schools and/or may provide service representatives to provide in-house training.

MDOT OPT offers an excellent opportunity at the annual Transit Vehicle and Maintenance Seminar every summer. TA personnel receive the latest vehicle information from manufacturers and suppliers. A trade show and informal workshops with vehicle vendors provide a forum for maintenance staff to get questions answered.

COOPERATION AND INTERACTION

Internal conflicts plague many organizations and transportation operations are no exception. A successful preventive maintenance program requires the cooperation and interaction of all parties, both in establishing the program and making it work daily. The following actions will help improve interpersonal relationships and reduce organizational conflicts.

- Involve all parties when developing inspection items, service intervals, and other interdepartmental maintenance.
- Be realistic in your expectations (a proper driver pre-trip inspection will involve increases in staff time and costs but should also improve vehicle reliability).
- Pay attention to administrative details. Who is responsible for what? Who prioritizes the repairs? Who decides on vehicle roadworthiness? Who answers to whom? These responsibilities need to be decided upon first and communicated to everyone.

SUMMARY

Preventive maintenance is an essential element of every transportation operation. A program tailored to your individual service and vehicle fleet will increase reliability, longevity, and safety. While preventive maintenance may be more expensive in the short run, it will likely result in the lowest overall life-cycle costs when related expenses are considered.

Exhibit 1 – Sample Vehicle Maintenance Plan

ABC Transit Vehicle Maintenance Plan

Maintenance Policy Statement

ABC Transit provides safe reliable vehicles for its employees and customers. Written procedures have been established to obtain daily pre-trip inspections, semiannual safety inspections and scheduled preventive maintenance in accordance with manufacturer's service intervals. We strive to complete vehicle repairs as efficiently and as quickly as possible. Individual vehicle records are maintained to document service intervals, warranty claims and equipment performance.

Daily Inspections

Daily inspections are performed by either the driver or transportation mechanics and are a key element to the early detection and remedy of potential failures. These inspections will detect any visible problems and will be conducted before the vehicle leaves the facility. If the vehicle is found to have significant defects it will be scheduled and fixed prior to being used. A vehicle pre-trip inspection (see Attachment 1) will be performed each time a vehicle is to be used.

Safety Inspections

Regularly scheduled safety inspections are also a key element to the early detection and remedy of potential safety-related issues. As the age of the fleet increases, the transportation mechanics may at their discretion schedule the safety inspections more frequently than once every six months. At a minimum, vehicle safety inspections must be performed every six months, using MDOT's Vehicle Safety Inspection Checklist (see Attachment 2). Our methodology for tracking and scheduling will be (*e.g. an Excel spread sheet, a white board in the maintenance garage, an Outlook calendar, etc.*) The safety inspections will emphasize everything affecting the safe operation of the vehicle. If the safety inspections are performed by an outside contractor, the mechanic must be certified for that class of vehicle and equipment. If the safety inspections find the vehicle to have significant defects, the vehicle will be scheduled and fixed prior to being used. Otherwise, the safety inspections will be reviewed and used to schedule other needed repairs and maintenance. For verification that inspections are completed on time, the agency director will also monitor the tracking on at least a weekly basis and sign off on the inspection forms once they are completed.

Routine Service and Maintenance Schedule

Preventive maintenance involves performing regularly scheduled maintenance services, adjustments, and inspections based on a predetermined interval of miles to minimize malfunctions. Routine service and maintenance is scheduled to meet or exceed manufacturers' recommended service intervals (see Attachment 3). Our methodology to determine when vehicle servicing is due is for the transportation mechanics to check the vehicle mileages daily and compare them with the service schedule. The mechanics will schedule service when the interval is less than 500 miles away from the time service is due. For verification that services are completed on time, the agency director will also monitor the tracking on at least a weekly basis and sign off on the work orders once they are completed.

Proactive vehicle maintenance is a primary goal of our maintenance program. Effective preventive maintenance means performing necessary repairs promptly to prevent further damage and to ensure vehicle safety. Removing a vehicle from active service until it is road-ready is also an option.

The transportation mechanics are responsible for ensuring all preventive maintenance and repairs are completed in a timely manner. The senior center director periodically checks maintenance records to ensure maintenance is not exceeding service intervals.

Record Keeping

Historical records are kept substantiating maintenance is being performed according to the manufacturers' recommendations. All vehicle maintenance becomes part of the vehicle's historical record. Each individual vehicle's record includes all daily inspections, six-month safety inspections, and routine maintenance records. The recommended way to maintain vehicle histories is to place important forms (safety inspections, maintenance records, etc.) in separate folders for each vehicle. The transportation mechanics ensure the maintenance work is being done in accordance with manufacturer's recommendations by periodically comparing maintenance records to ABC Transit's Vehicle Maintenance Plan. The Director ensures compliance for proper maintenance by meeting **<how often>** with the maintenance staff to review work that has been completed or is in process.

Summary

Preventive maintenance is an essential element of every transportation operation. ABC Transit believes its vehicle maintenance plan increases vehicle reliability, longevity, and safety. While preventive maintenance may be more expensive in the short run, it likely results in the lowest overall life cycle cost.

Exhibit 2 – Sample Pre-Trip Inspection Form

Pre-Trip Checklist

Date ___/___/_____

Mileage: End _____

Vehicle # _____

Start _____

Total _____

Driver's Signature _____

Check before each trip:

List Additional Comments Below:

Headlights	
Turn Signals	
Brake Lights	
Brakes	
Cycle Lift	
Fire Extinguisher	
Windshield Wipers	
Oil Level	
Coolant Level	

Check Once a Week

Transmission Fluid	
Power Steering Fluid	
Windshield Washer Fluid	
Belts	
Hoses	
Leaks	

Exhibit #3 – Sample Safety Inspection Form

VEHICLE SAFETY INSPECTION CHECKLIST

Vehicle safety inspections are required every six months.

Put an X in the box for ok, O for needs attention, or NA for does not apply

VEHICLE NO.	TRANSIT AGENCY			
MAKE	MODEL	YEAR	MILEAGE	V.I.N.
TECHNICIAN SIGNATURE			MECHANIC CERTIFICATION NO.	INSPECTION DATE

A	GENERAL CONDITION	J	SAFETY EQUIPMENT		71. Volt/Amp Gauge
	1. Body, Bumpers, Trim		35. Flares/Reflector Triangles		72. Oil Pressure Gauge
B	TIRES/BATTERY		36. Fire Extinguisher Charge/Date		73. Engine Temperature Gauge
	2. Tread depth	K	DRIVER'S SEAT		74. Air System Pressure Gauge
	3. Tire Pressure		37. firmly Mounted		75. Low Air Pressure Light/Alarm
	4. Wheels & Lug Nuts		38. Adjusts & Latches		76. Speedometer/Odometer
	5. Battery Terminals & Compartment		39. Seatbelt Operation		77. Air Restriction Gauge/Induction System
C	FLUIDS	L	HEATER/DEFROSTER	Q	BRAKES
	6. Engine Oil Level		40. Fans Operate F/R		78. Parking Brake
	7. Coolant Level/Freeze Protection _____ °F		41. Heaters Operate F/R		79. Brake Pedal Low/ Soft? Hard? Normal?
	8. Brake Fluid Level		42. Defroster Operation		80. Brakes Pull, Noisy
	9. Transmission Fluid Level		43. Air Conditioner System Operation		81. Air Chambers/Slack Adjusters
	10. Power Steering Fluid Level	M	LIGHTS, HORN		82. Air Lines/Tanks/Drains
	11. Windshield Washer Fluid Level		44. Stepwell	R	TRANSMISSION-DRIVE TRAIN
D	DOORS		45. Passenger Area		83. Holds in Park Position
	12. Open & Close Properly		46. High Beam Headlights & Indicator		84. Does Not Start In Gear
	13. Won't Open Accidentally		47. Low Beam Headlights		85. U-Joints
	14. Latches, Handrails, Hinges		48. Dimmer Switch		86. Differential/Rear Axle
	15. Seals Out Fumes & Dust		49. Turn Signal Lights & Indicators	S	STEERING
E	FLOORS & STEPS		50. Hazard Flashers & Indicators		87. Free Play
	16. Clean & Free of Debris		51. Running Lights		88. Steering Force
	17. Loose Floor Covering/Weak Flooring		52. Reflectors		89. Pulls In Either Direction
	18. Step Tread Covers & Fasteners		53. Brake Lights		90. Power Steering Pump/Gear Box
F	SEATS		54. Tail Lights		91. Linkage/Ball Joints/King Pins
	19. Sharp Edges/exposed Metal		55. License Plate Light	T	SUSPENSION F/R
	20. Upholstery/Springs		56. Back-up Lights		92. Shocks/Mounts/bushings
	21. Firm Mounting		57. Back-up Alarm		93. Springs/Clamps/Shackles
G	GRAB-RAIL STANCHIONS		58. Horn		94. Stabilizers/Tracking Bars/Bushings
	22. Padded Properly	N	WIPER/WASHER	U	EXHAUST SYSTEM
	23. Firmly Mounted		59. Arm Tension		95. Exhaust/Tail Pipes
	24. Other Padding		60. Blade Condition		96. Muffler/Catalytic Converter
H	WINDOWS		61. Wiper/Washer Switch w/Delay		97. Hangers/Clamps
	25. Safety Glass		62. Washer Aim & Coverage	V	FUEL SYSTEM
	26. Vision Obstruction	O	MIRRORS		98. Lines/Fittings/Filter
	27. Operation		63. Mounted Firmly		99. Leaks
	28. Sun Visors		64. Interior View		100. Tank Mounts/Drain/Fill Cap
I	EMERGENCY EXITS		65. Exterior Flat Rear View	W	LIFT/RAMP/SECUREMENTS
	29. Doors/Windows Work Properly		66. Exterior Convex Rear View		101. Remote Control
	30. Doors/Windows Latch Properly		67. Exterior Front Cross View		102. Wheelchair Stops/Handrails
	31. Roof Hatch Operation	P	ENGINE OPERATION		103. Restraints/Tie Downs Operation
	32. Labeled Properly		68. Starting		104. Stop Request
	33. No Obstruction to EXITS		69. Excessive Smoking		105. Adequate Padding
	34. Door Ajar Warning Alarm		70. Instrument Warning Lights		106. Manual Lift Operation

REMARKS:

Exhibit #4 – Sample Maintenance Schedule

Component	Service Interval
Engine Oil & Filter	Every 6,000 miles
Chassis Lubrication	Every 6,000 miles
Air Filter	Inspect at oil change, replace as needed
Fuel Filter	30,000 miles
Wheelchair ramp & securement	Inspect at oil change, replace at needed
Vehicle cleaning	Weekly
Disc & Drum Brake Service	Inspect at oil change, replace/repair as needed
Transmission service	60,000 miles
Drive axle service	As needed, inspect at 6 months
Engine cooling system service	100,000 miles
Air conditioning system	Inspect at oil change, repair as needed
Safety Inspection (required)	Every 6 months