Missouri's Model Transit Bus Safety and Security Program

VEHICLE MAINTENANCE

SECTION THREE

MISSOURI DEPARTMENT OF TRANSPORTATION
(MODOT)
TRANSIT SECTION

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Proper maintenance of vehicles and equipment is an essential element of a safe and efficient transit operation. Maintenance can easily be neglected, as its role in the operation is often misunderstood by upper management. The proper role of maintenance is to ensure reliability of service and equipment, to ensure that the organization is in compliance with all applicable regulations and to place into service the safest vehicles possible. The fleet supervisor must be able to demonstrate to management the potential for loss if a maintenance program is ignored or abridged. Equipment failure could cost the fleet in both dollars and customer relations. Failure to comply with regulations could result in unnecessary costs due to unplanned and poorly organized programs to meet mandated standards. Vehicles placed into operation in a less than safe condition may also become a contributing factor to accidents.

The maintenance requirement for buses, vans and other transit vehicles is typically established by the manufacturer, as well as the Code of Federal Regulations (49-CFR). The maintenance requirements for parts, lubricants and other vehicle components should be recorded and a process should be established for monitoring these elements, completing required services, reporting equipment problems, making necessary repairs and replacing parts as scheduled. Maintenance programs are critical to keeping buses and other transit vehicles in safe operating condition and can help eliminate unnecessary costs and losses. Maintenance programs in use today have many aspects and employ many techniques. There are basically four key elements of maintenance that should be considered. These elements are:

1. Maintenance Records
2. Planned Maintenance
3. Vehicle Inspection
4. Vehicle Specification

MAINTENANCE RECORDS:

The purpose of a record keeping system in a transit organization is to implement effective control and proper analysis. A vehicle expense control record system is the best tool to analyze the needs of the maintenance function of a transit fleet. The heart of any expense control record system is the vehicle history file. This record lists expenses for each fleet vehicle and typically includes:

- Completed repair orders,
- Vehicle data, and
- An update of past service.

The success or failure of the expense control system is heavily dependent upon the quality of the record keeping system within the operation. The records must be accurate, up-to-date and describe the problems encountered fully. The expenditures must be recorded when and where they occur. This is necessary so that a thorough and realistic analysis of scheduled maintenance and downtime can be recorded.

The vehicle history file allows the fleet supervisor to make proper decisions on a vehicle's status before proceeding with extensive or expensive repairs. This history file should always be studied, by the supervisor before any repair order is issued, to determine

- If the current problem is chronic;
- If the repairs have been excessive;
- If maintenance has been performed at proper intervals;
- If there is a problem with mechanics performing unnecessary or improper repairs.

RECORD FORMAT:

Many systems – both hard copy and electronic – for vehicle maintenance reporting are available to the industry for use by any type and size transit operation. They present and recommend standards for the data to be recorded as well as the method of recording and often include the necessary forms, software and hardware. With this guidance, individual transit organizations may establish intervals for inspections, adjustments, repairs and replacements as determined by manufacturer specifications and operational needs. These systems are adaptable to either data processing or manual record keeping procedures. The essentials of a good system should include:

- Meeting all regulatory requirements (see Appendix A, 49-CFR 396).
- Identification and classification of vehicles and their components, the operating conditions affecting the maintenance requirements of the vehicles and the conditions and performance of maintenance.
- Standard codes to record these identifications and classifications and to facilitate the processing of maintenance data into useful information. Such codes may include:
  - Activity (vehicle work assignment)
  - Reason for repair
  - Work accomplished
  - Repair class (timing of repairs)
  - Repair location
  - Part failure
  - Vehicle type
  - Vehicle component
  - Indirect labor
  - Direct labor (mechanic)
- Standard forms to record data should include:
  - The vehicle master record
  - The vehicle control identification
  - A driver's vehicle condition report
  - Repair order
  - Repair order log
  - Time card (direct and indirect labor)

VEHICLE MAINTENANCE REPORTING STANDARDS (VMRS):

The Vehicle Maintenance Reporting Standards (VMRS) is the standard equipment maintenance management and parts inventory control information system of the motor fleet industry. VMRS is based upon standard data codes developed by the American Trucking Association's Management Systems Council.

- These codes describe the vehicle by:
  - Its major components, assemblies or parts;
  - Its physical characteristics; and
  - What has happened to it and what was done to it, by whom, where and at what cost.

Not only does this system allow for the means of identifying costs but it may also be used by transit organizations for major decisions regarding capital expenditures, operational and labor requirements and safety programs. Data that is readily captured at the maintenance shop level can be processed to provide management information to:

- Identify costs for financial analysis and accounting purposes,
- Provide a basis to substantiate warranty claims,
- Analyze labor productivity,
- Analyze facility management,
- Analyze operational requirements, and
- Assist safety programs to provide creditable and comparable information to the regulatory agencies.

Although the VMRS system may be implemented manually or electronically, one of the major advantages of electronic data processing is the ability to collect, process, store and rapidly retrieve vast amounts of data in the form of useful and timely information. As transit organizations become more experienced in using a VMRS system, expansion into other applications, like inventory control, can occur.

A belief, by management, that a reduction of operating costs may be achieved by cutting maintenance expense is always a possibility. An adequate record keeping system can assist the fleet supervisor in counteracting this misconception. Records can clearly show:

- How maintenance dollars are being spent;
- Problems of abuse or overloading;
- When vehicles have exceeded their economic life; and
- Expenditures listed by location, driver, mechanic or other criteria may indicate abnormal patterns.

Vehicle history data must be kept current as repairs are made and completed. They must also reflect skillful handling of company dollars and equipment if they are to have any credibility with upper management.

PLANNED MAINTENANCE:

There are two basic types of vehicle maintenance. These are demand maintenance and planned maintenance. Demand maintenance, as a repair procedure, is conducted typically at critical points or at the time of a vehicle breakdown. This can produce an unreliable account of maintenance costs if unscheduled downtime losses, or actual on-the-road breakdowns are not recorded in the vehicle history data, therefore, not included in the total maintenance cost data. Demand maintenance is difficult to control and is almost impossible to use to establish proper equipment replacement and maintenance criteria. A component failure caused by poor maintenance can also damage related parts. This damage may not be noticed when repairs are performed as it is not a part of the demand service and repairs. Such damage can possibly result in yet another breakdown.

The preferred form of maintenance is planned or preventive maintenance. This form of maintenance makes it possible to control costs by budgeting both time and money for repairs. In this system, vehicles are scheduled at selected intervals for specific services. This has proven to be effective in reducing breakdowns and the resulting problems they cause for the fleet. Three basic requirements for a well planned maintenance system are;

- The system must be designed around the specific vehicles it is to maintain.
- The system must fit the conditions in which these vehicles operate.
- The system must change when either vehicles or operating conditions change.

When these criteria are met, planned maintenance systems can produce substantial savings in maintenance costs. The scheduled requirements for the maintenance procedures should be tailored to the fleet and should consider:

- The type of vehicle,
- The load-carrying components,
- The driver
- Vehicle age,
- Vehicle usage,
- Operating conditions and environment,
- The mechanical skills of the employees, and
- Load-moving components, if any.

In the simplest terms, planned maintenance means control of maintenance costs. Vehicle life may be extended and driver morale should be higher if the equipment is dependable in its performance. Factors such as these can also help reduce incidents and increase customer service reliability. Table 1 provides additional information on the elements typically found in each of these categories.

Table 1. Examples of Preventive Maintenance

Category	Preventive Maintenance Elements
Daily Servicing	Pre and post-trip inspection: Full fuel tank levels Proper fluid levels Safety devices in working order Interior and exterior clean and no damage noted
Periodic Inspection	Periodic checks to detect and repair damage or wear conditions before major problems occur: Tire wear Suspension Belts
Interval Related Maintenance	Based on experience and manufacturer guidelines: Lubricating oils Brake fluid Tires Parts
Breakdown Maintenance	Necessary when failure in vehicle parts or systems requiring the vehicle to be taken out of service: Flat tires Engine breakdowns Loss of brakes – brake system failure

The maintenance schedule should be matched to the vehicles operated by the transit agency, local conditions and the agency policies and maintenance practices. Typical maintenance intervals for different types of vehicles and operating environments are:

- 3,000 miles for gasoline vehicles used in urbanized areas,
- 4,000 miles for gasoline vehicles used in non-urbanized areas,
- 4,000 miles for small diesel vehicles, and
- 6,000 miles for medium-to-heavy diesel buses.

Table 2 provides an example of the elements typically inspected at different intervals in maintenance programs. This information can be used by rural and small urban agencies to develop a maintenance program matched to the local conditions and the specific types of vehicles operated.

See Appendices B, C and D for examples of Pre, Post, and Preventative Maintenance Checklist forms.

Table 2. Examples of Preventive Maintenance Intervals and Elements Inspected

Interval	Elements Inspected
Two months or 3,000-4,000 miles for gas and small diesel buses and 6,000 miles for medium/heavy buses, which ever comes first	-Tire tread and pressure -Wheel rims for cracks -Lug nuts for tightness -Oil and fluids leaks and belt condition -Brakes, including master cylinder fluid level -Exhaust system -Seatbelts -Passenger seats -Brakes -Change engine oil -Change oil filter -Spark plug wires -Belts and hoses -Rear axle differential oil -Wheelchair securement and restraint systems -Cycle wheelchair lift -Windshield wipers and fluid -All interior and exterior mirrors -All exterior lights -Headlights (high and low beam) -Back-up lights and alarm -Taillights, Stop lights, License plate light and plate taillight -Turn signals and Hazard warning lights -Radio(s) -Fare box
Six months or 8,000 to 12,000 miles depending on fleet experience and vehicle maintenance requirements	-All of the above -Steering wheel play -Parking brake -Brake and acceleration pedals -Sun visor -Horn -Signs -All window glass, door glass & window operations -Power steering fluid level -Transmission fluid level -Batteries -Antifreeze and condition -Exterior for body damage and condition -Air filter -Shock absorbers and springs or suspension system -Wheel bearings -Fuel tank condition -Alternative mountings for tightness -Air conditioning system -Rotate tires
12 months or 24,000 to 36,000 miles	-All of the above -Detailed frame and body checks, including bolts/nuts, rivets and welds -Pull all wheels, measure and inspect brake drums, rotors, brake pads and calipers -Change rear axle differential fluid -Change fuel filter and air filter -Clean engine and engine compartment (as needed)

VEHICLE INSPECTION:

The key to a good vehicle loss prevention program is the driver. The driver is often the first person who may notice a defect in a unit, whether or not the defect is safety related. The driver should conduct a thorough inspection and make a written report before and after operating a vehicle. Because the inspection procedures provide additional assurance of safe operating conditions at time of departure, most fleets include these procedures as a part of the organizations standard operating policies and rules.

Pre- and Post-Trip Inspection – A pre-trip inspection should be conducted to ensure that vehicles are in good working order and are ready for service. A pre-trip inspection can best be accomplished if it is done in an organized manner. In most cases, the single – complete circle – inspection of the vehicle is the best method to use and should take an operator approximately ten (10) minutes to complete. Pre and Post-Trip inspections may be completed every time there is a change in operator (*see Appendices B and C for example inspection checklists*). What follows is an example of a simple nine-step inspection:

1. **Check the engine** – before starting the vehicle, check the oil, radiator, brake fluid and coolant levels. Check belts and hoses for cracks, splits and worn spots. Check for loose battery cables and corrosion. Check for loose wires and fluid leaks. Start engine and check for leaking fluids.
2. **Check the dashboard and operator compartment** – Check turn signals, flashers, mirrors, lights, windshield wipers, washer and gauges. Check seat, seat belt, horn, steering wheel and radio(s).
3. **Check the safety equipment** – Check to see that the first-aid kit, flares, accident kit, fire extinguisher and other safety equipment are properly located in the vehicle and are in good working order.
4. **Check exterior lights** – With the engine running, check all exterior lights; headlights (high and low beams), parking lights, brake lights, turn signals, emergency flashers, back-up lights and clearance lights.
5. **Check the suspension** – Check the suspension to see if the vehicle is lower on one side or in the front or back.
6. **Check the tires** – Check the tire pressures and tread for depth, wear, loose parts, nails and other foreign objects.
7. **Check outside the vehicle** – Check windows, doors, bumpers and vehicle exterior for scratches, dents and broken/cracked glass. Check the exhaust for loose parts, noise and damage.
8. **Check the wheelchair lift and securement** (if applicable) – Cycle the wheelchair lift and check wheelchair securement devices in the vehicle.
9. **Check/test the brakes** – Check the brake system for proper operation and sponginess.

A post-trip inspection should be completed at the end of an operator's schedule to identify any problems that may have developed during operation.

A post-trip inspection may use the same procedures and form as the pre-trip inspection or the process may be modified. *See the Appendices B and C for sample pre and post-trip forms*.

Out-of-Service Condition – When any commercial motor vehicle(s), by reason of its mechanical condition or loading, is determined to be unsafe and likely to cause an accident or breakdown, or when such conditions would likely contribute to loss of control of the vehicle by the driver, the vehicle should be placed out-of-service. No transit agency should require, nor should any person operate any commercial motor vehicle declared and marked "out-of-service" until all required repairs have been completed. The Commercial Vehicle Safety Alliance (CVSA) establishes the North American Uniform Vehicle Out-of-Service Criteria and is subject to annual review and revision. For a complete and current copy of the criteria, visit the CVSA site at http://www.cvsa.org/.

VEHICLE SPECIFICATION:

Vehicle design and specification affect a fleet's ability to perform safely and efficiently. A vehicle at work produces services and profit; in the repair shop it costs money. Selection of the right vehicle is more than just an acquisition or replacement process. To properly specify a vehicle requires experience, knowledge of components and equipment and an understanding of the jobs to be done. For this reason, specifications for transit vehicles should be jointly developed by maintenance, safety, operations and purchasing personnel. Some of the most significant trends in specification are toward economy of operation and safety for the driver. Some items to be considered should include:

- Wind Deflection – transit vehicles can benefit from aerodynamic design that can aid in economy and in some applications, vehicle stability.
- Tires – radial tires and re-treads contribute towards economic operation. Tubeless designs eliminate some maintenance problems. Fleet managers may specify different tread designs based upon their experience and type of operation.
- Vehicle Entry – slips and fall accidents are a major contributor to driver and passenger injuries. Adequate hand rails, non-skid surfaces and extra steps, both internal and external should be considered.
- Interior – standard design reduces the time needed when transitioning between vehicles is required. Seating, housekeeping, clearance and comfort are additional considerations to assist driver and passenger's safety.
- Visibility – reduction of blind spots through the use of extra mirrors, wide-angle vision assistance devices and heated mirrors to prevent ice build up are just three examples of safety related vehicle specifications.
- Conspicuity – the application of reflective (conspicuous) materials and surfaces to a transit vehicle can greatly increase day or night time visibility and identification.

- Splash and Spray – mud flaps designed and installed to absorb and redirect road spray downward can increase visibility in inclement weather and decrease unwanted spray on other road users.

When new vehicles are added to a transit fleet, it may be necessary to instruct drivers on the procedures for their use and operating features. Training of this kind may alleviate many hazards and prevent misuse or abuse. Vehicle specification is a point of control for the fleet supervisor. If the proper vehicle is selected, the job of service, maintenance and supervision becomes easier and more efficient.