Scheduled Maintenance

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> Scheduled maintenance is planned component repair or replacement, often triggered by preventive maintenance inspections, pre-trip and post-trip inspections, regular oil changes and grease jobs, etc., all of which are also scheduled maintenance activities.

Unscheduled Maintenance

> Unscheduled maintenance is work that results from breakdowns, unexpected failures, often triggering road calls and usually causing expensive downtime of labor crews.

One of the goals of a successful and efficient public transportation provider is to promote vehicle safety and extend vehicle life. Vehicle reliability and longevity can only be accomplished by implementing a proactive maintenance program. Proactive maintenance is the practice of identifying potential vehicle component defects for replacement or repair before the vehicle experiences a failure. This practice requires extensive knowledge of the vehicle fleet as well as analysis of maintenance activities and failure trends.

Proactive maintenance is preferable to reactive maintenance when managing a fleet of vehicles. Responding to failures after they happen, instead of anticipating them, limits the ability of the agency to plan and schedule their maintenance. This creates a continual cycle of responding to chance failures and making emergency repairs to get vehicles back in service, creating an unmanageable and costly situation.

Some managers succumb to reactive maintenance because they would prefer to limit the breaks in service caused by vehicle downtime. However, vehicle downtime associated with failures and mechanical breakdowns creates long and unpredictable breaks in service that the manager was trying to avoid. Although initially it may seem more difficult and costly to operate a proactive maintenance program due to the scheduling and cost of repairing and replacing vehicle components before they experience failure, the long-term benefits of a proactive maintenance program far outweigh the perceived alternative.

Proactive maintenance begins with preventative maintenance inspections. These inspections can include pre-trip and post-trip checks, oil changes and other related services, and preventative maintenance inspections based on predetermined mileage intervals for vehicle components identified in the OEM guidelines and/or FDOT PM Standards Manual. These are all scheduled preventative maintenance activities designed to effectively locate and identify potential vehicle component defects.

It is important that proper work be identified during this stage. Drivers are the first line of defense against unexpected failures. Mechanics rely on the observations of the driver while operating the vehicle to identify potential failures. Mechanics must also be skilled and familiar with the vehicles they are inspecting and follow guidelines regarding how preventative maintenance inspections should be carried out. A mechanic must have this knowledge and experience to identify the correct repair to be made. Without proper work identification, maintenance resources will be wasted, and unnecessary or incorrect work will be planned, ultimately wasting valuable maintenance resources. When the proper work is identified, a vehicle can then be scheduled for the appropriate repair.

When planning scheduled maintenance activities, a manager has the unique opportunity to plan for vehicle downtime. It should be the maintenance department's goal to minimize downtime attributed to both scheduled and unscheduled maintenance. A key objective of proactive maintenance is to identify potential failures with sufficient lead time to plan and schedule the corrective work before actual failure. If the maintenance function is successful, the unscheduled downtime will be reduced. It is equally important to measure scheduled downtime for comparison. Of course, not all unscheduled maintenance can be avoided. Even the most efficient preventative maintenance program will encounter unexpected failures. However, if proper maintenance activities are scheduled, intermittent failures will not consume the daily maintenance workload. Eighty percent (80%) of all maintenance should be scheduled maintenance. At least, this should be an agency's goal. This should be the benchmark and goal of an efficient proactive maintenance program.

By analyzing the maintenance history of a vehicle fleet, a manager can identify maintenance trends that will assist with establishing scheduled replacements and repairs. If maintenance trends are found exclusively for specific vehicle manufacturers in a fleet, a manager can begin a campaign.

Campaigns are scheduled repairs that take place on an entire series of equipment or buses made in response to a common problem. Campaigns can be recalls initiated by the manufacturer, the National Highway Traffic Safety Administration, or an internal campaign initiated by a history of problems on a specific fleet. Effective data collection and analysis is an important component of this process.

Campaigns can involve any component or part of a vehicle that can cause a premature failure or create a safety hazard. Examples of campaigns can vary from relocating a fuse holder that was placed too close to a heat source to replacing transmissions at a predetermined mileage interval. The replacement can be scheduled as part of a regularly scheduled preventative maintenance inspection or as a separate maintenance function. All records generated from the campaign from the beginning phase to the completion date must be filed in a place where they

are accessible should a justification be needed for why these replacements and repairs are taking place.

Similarly, managers can use a vehicle fleet's history of repairs and failures to establish wear tolerance policies. Wear tolerance describes the amount of wear a vehicle component can tolerate before it experiences a failure. Some component wear can be determined during preventative maintenance inspections, such as tires and brake pads. In cases where the amount of wear can be observed, a manager can establish a wear tolerance policy that provides mechanics with a threshold for the amount of wear that can be tolerated before vehicle safety is compromised. Again, all records generated from the development of a wear tolerance policy should be filed and readily accessible should a justification be required.

Several factors can influence the rate at which a vehicle will reach its wear tolerance, including annual mileage, average operating speed, passenger loads and operating environment. Higher annual mileages increase the rate of vehicle deterioration. Also, lower bus operating speeds are usually indications of more frequent stops and starts that lead to reduced life expectancy for drive trains, brakes, and other vehicle components. Combinations of annual mileages and operating speeds also have an impact on both the timing of certain component replacements and annual operating and maintenance costs.

Scheduled component replacement is designed to replace the components before failure occurs at the end of the component's useful life. Failure patterns can help in selecting the correct procedure for component replacement. Four types of component replacements are:

1. **Operate Until Failure**

   This type of maintenance implies all repairs will be corrective. In this situation, work flow cannot be effectively, making it the least preferred strategy. However, it can be the most cost effective under two conditions -- if the item is not mileage-dependent and cannot be monitored or if it is just as cost effective to replace the item after failure as it is before failure. Examples are fuses, light bulbs, etc.

2. **Condition Based Maintenance**

   Condition based maintenance can predict approaching failures when monitoring a component is possible. Brake shoe wear and oil consumption are examples of condition based maintenance. The part or component is used until nearly the end of its life, but it is replaced before an in-service failure causes significant additional maintenance costs. Unpredictable failures are also nearly eliminated. These are monitored through regularly scheduled preventive maintenance inspections and data analysis. An example of this type of maintenance is wear tolerance monitoring.

3. **Fixed Mileage Maintenance**

   Fixed mileage maintenance can be carried out where there is a known relationship between miles traveled and failures. This type of maintenance has a degree of chance variation unlike condition based maintenance. For example, a specific transmission model has shown a history of failure at 150,000 miles. So, a manager initiates a campaign to overhaul the transmission before the vehicle reaches 150,000 miles. Some transmissions will be repaired long before they might otherwise fail. However, if the failure pattern is predictable, then this type of maintenance on select components is appropriate as it eliminates a disabled vehicle, an in-service failure, and the costs incurred by performing an unscheduled repair. The maintenance manager can schedule work flow more efficiently and reduce road calls while increasing service reliability.

4. **Design Out Maintenance**

   Design out maintenance is a procedure that attempts to remove the maintenance problem. On occasion, manufacturing designs appear feasible but do not work in an actual operating environment. If maintenance costs are excessive the manufacturer may need to redesign the component or the transit agency may have to purchase an alternate component or system.

Maintenance managers must analyze each of these options and select the most efficient course of action to minimize total maintenance costs and vehicle downtime. If it costs just as much to repair the item after it fails as it does before, then it should be replaced after it fails. If a failure disables the vehicle and results in a road call or if additional damage is caused by operating the component until failure, then all expenses related to the failure must be included in the estimate. Safety always overrides cost minimization when analyzing preventative and corrective maintenance.

It is important to remember that component replacement intervals are unique to each transit agency. For example, rough terrain and environmental conditions such as hot, humid climates may increase or decrease the mileage intervals at which a component may need to be replaced. It is important that maintenance managers develop a failure pattern for their own fleet in order to ensure accurate, scheduled replacement intervals.

Establishing campaigns, wear tolerance policies, and component replacement schedules allow the preventative maintenance process to become self-sustaining. Even then, the policies should be continuously reviewed and analyzed for improvement opportunities. Actual vehicle performance must be monitored relative to the required and desired performance. This

guarantees maintenance improvement and vehicle reliability. Implementing a proactive maintenance program that focuses on scheduled maintenance will reduce costs by providing the maintenance manager a chance to plan for the purchase of necessary parts and arrange for vehicle downtime. An efficient preventative maintenance program will also ensure vehicle safety and longevity which are essential to guaranteeing that the maximum life of the vehicle is met.