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NEWSLETTER FOR MANUFACTURING COMMUNITY

SECTION 1: INTRODUCTION

1.1 Leece-Neville's Training Manual for Preventive Maintenance and Diagnostic Procedures on Heavy-Duty

The objective of this training manual is to provide the customer with a step by step, easy to understand outline of the procedures for maintaining and diagnosing a heavy-duty vehicle's electrical system.

As a service technician, you should consider yourself as the "doctor" who cares for your company's heavy-duty vehicles. It's your responsibility to make sure the vehicles are well-maintained. And it's your job to accurately diagnose and repair equipment problems if they occur.

Unfortunately, problems with the vehicle's electrical system are often misdiagnosed. What happens as a result? Well, most industry studies indicate that approximately 55% of alternators and starters returned under warranty to manufacturers, and noted as "defective", are later discovered to be in fine working order.

Now it's certainly true that electrical components can become damaged due to excessive heat and vibration, voltage spikes, careless handling and misapplication. Components can also become damaged by excessive heat, whenever they are forced to operate at continuously high levels of electrical output. (For instance, the addition of even a few accessories - such as mobile telephones, CB radios, portable CD players, coolers, microwaves, satellite tracking, bunk heaters, inverters, etc. - can overburden the amperage capacity of the originally installed alternator.)

Generally speaking, however, electrical components - such as alternators and starters - are designed to perform trouble- free for many thousands of miles.

So with knowledge and training, you'll be able to properly maintain your company's vehicles. And if problems occur in the electrical system, you'll be able to accurately diagnose and correct them, instead of immediately assuming that an electrical component itself is faulty.

That indeed is the goal of this training manual.

1.2 The Heavy-Duty Vehicle's Electrical System

If a technician does not have a clear understanding of how a vehicle's electrical system works, it's nearly impossible to accurately diagnose a problem.

A vehicle's electrical system is comprised of three elements: the battery system, the charging system, and the starting system. All three systems work together as a team.

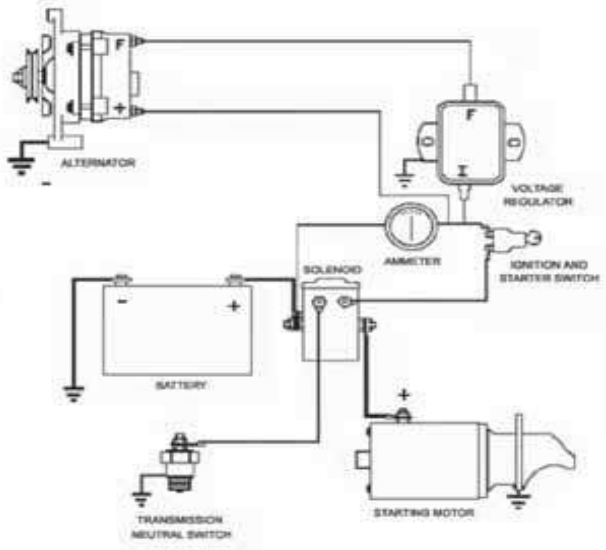

Figure 1: Vehicle electrical system

As with any team, each member has a specific and important job to perform. When diagnosing an electrical problem, it's necessary to consider each team member as potentially contributing to the problem.

That's why we've organized this training manual to cover the battery system first, followed by the charging system and finally the starting system.

You'll find that each of these three sections starts with an overview of how the system works, then moves on to cover various preventive maintenance and diagnostic (i.e. troubleshooting) procedures.

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1.3 The Importance of Using Proper Preventive Maintenance Procedures

Throughout this manual, we'll underscore the importance of preventive maintenance, and show you the steps to become very proficient at it. Equally important, we'll show you how to perform preventive maintenance safely.

The advantages of performing preventive maintenance can be summarized in two ways. First, it enhances the lifespan of electrical components; and second, it improves the likelihood of trouble-free operation, thereby minimizing vehicle downtime.

1.4 The Importance of Using Proper Diagnostic Procedures

There's absolutely no question that diagnosing a problem in a vehicle's electrical system can be tedious and time consuming. However, spending the upfront time required is much more efficient than having the vehicle's driver come back to you with an uncorrected problem. Simply put, it's important to take enough time to properly diagnose and correct the real problem.

To accurately diagnose an electrical problem, you need to equip yourself with two things: the proper tools and the proper techniques.

We'll provide diagrams to show how to connect the testing devices to the vehicle's electrical components. We'll provide charts to reveal what are acceptable readings on the various devices. And as in the preventive maintenance section, we'll show you how to safely perform diagnostic procedures.

1.5 The Importance of Selecting the Proper Electrical Components

In the event that your diagnostic procedures point to a faulty electrical component, you'll need to carefully select the correct replacement component.

It's not enough to simply replace an alternator or starter, for example, with an identical version of the faulty part being replaced. There are two primary reasons why this is so. First, there's a chance the faulty part's specifications never actually met the vehicle's amperage demands. Second, the vehicle's amperage needs might have increased over time.

In any case, a new component needs to support the vehicle's electrical load requirements. This is especially true with newer vehicles' highly sophisticated computer systems, which need to be closely integrated with electrical systems components.

Voltmeter


Ammeter

Carbon pile tester

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1.6 The Importance of Following Safety Precautions

We want your vehicle to operate trouble-free. But we also want you to follow safety precautions when performing preventive maintenance and diagnostic procedures.

Whether you're working on the battery system, charging system, or starting system, make sure the vehicle's wheels are securely chocked and the vehicle is out of gear. When working on any of these three systems, always wear safety goggles or a face shield, never smoke, and do not wear jewelry or loose fitting clothing.

In the battery system section, we've listed several precautions to follow when recharging batteries. Here are some additional precautions to adhere to:

A. Always follow the battery manufacturer's instructions when equipment such as a battery charger or tester is used.

B. Never lean over a battery during charging, testing, or "jump starting" operations.

C. Don't break "live" circuits at the battery's terminals, because a spark invariably occurs where a "live" circuit is broken.

D. Keep batteries protected from sparks and open flames; never smoke near a battery. Batteries emit colorless hydrogen gas, which is extremely flammable; they can explode if they come in contact with sparks, flames, or ashes.

E. Be certain that battery charger cable clamps or booster leads are clean and making good connections. A poor connection can cause an electrical arc, which in turn can ignite the battery's gases and cause an explosion. Sparks can occur as a result of loose cable connections, metal tools making contact between the battery terminals, and metal tools making contact between the ungrounded battery terminal and adjacent metal parts that are grounded. Don't use the top of the battery as a tool rest.

F. Do not charge a battery unless you are thoroughly familiar with the step-by-step procedure for using the battery charger.

G. The room in which you're charging a battery must be well-ventilated.

H. Loose clothing shouldn't be worn around moving parts.

I. Keep in mind radiator cooling fans can be thermostatically controlled and could turn on at any time.

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SECTION 2: THE BATTERY SYSTEM

2.1 An Overview of the Battery System

To begin the topic of the battery system, we've provided you with some basic information on how the battery system functions.

Each cell of a battery consists of positive plates, negative plates, and an electrolyte solution. Batteries produce electricity because of a chemical reaction between these three elements.

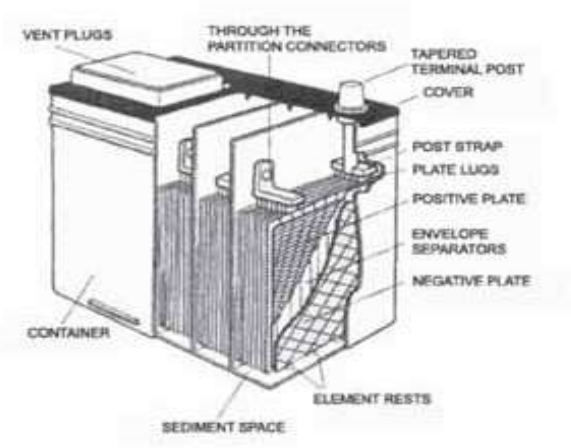

Figure 3: Battery components

In a fully-charged battery, the positive plate consists of lead peroxide (the symbol PbO_2), which is also called lead dioxide. Each molecule of PbO_2 consists of one lead atom and two oxygen atoms. The negative plate is sponge lead (the symbol Pb), which may be composed of an alloy of antimony or calcium. The electrolyte solution is sulfuric acid (the symbol H_2SO_4) diluted with water (H_2O).

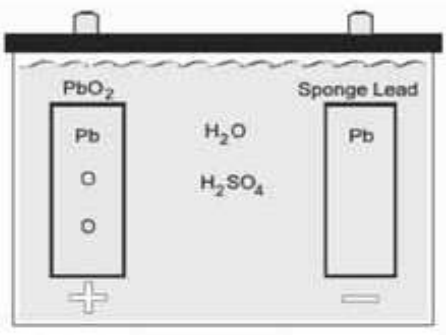

Figure 4: Fully charged battery

When an electrical load is placed on a battery, a chemical reaction takes place. The sulfate molecules in the electrolyte break off and attach themselves to the negative and positive plates. At the same time, the oxygen atoms from the lead peroxide positive plates go into the electrolyte solution to join with the hydrogen atoms, forming H_2O or water. The sulfate molecules moving to the plates and the oxygen atoms moving to the solution release energy. This is called the discharge cycle.

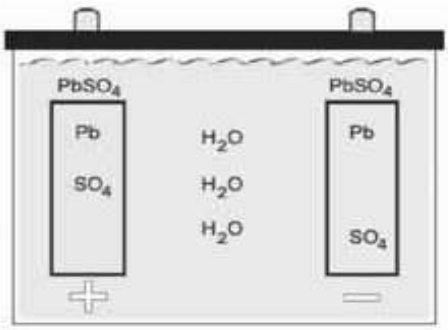

Figure 5: Fully discharged battery

When the battery is fully discharged, both plate are lead sulfate (the symbol $PbSO_4$), and the solution is water. In the charging cycle, the sulfate molecules return to the solution, and the oxygen molecules in the water return to the positive plates.

Fully charged and fully discharged states are the extremes. Normally, a battery is partially charged or partially discharged. For example, a battery may be 25% discharged, meaning that 25% of the chemical reaction has taken place and 75% of the battery is in its original chemical condition.

2.2 The Primary Causes of Battery System Malfunction

Before dealing with preventive maintenance and diagnostic procedures for the battery system, we're going to cover certain environmental and usage handling factors that can cause the system to malfunction.

Excessive heat. When batteries are subjected to high temperatures, positive plates corrode quickly and battery cells dry out.

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Cold weather. Because engine oil thickens in cold temperatures, it makes engines harder to crank. This places a heavier and longer-lasting drain on the battery.

Vibration. If a battery is not securely fastened to the vehicle's frame, the resulting vibration can shed the active material from the battery's plate grids.

Fast charging. Using a high charging rate to quickly charge batteries can be damaging, if the battery becomes overheated and begins gassing.

Deep cycling. Repeated deep cycling will eventually cause a battery to lose its ability to accept a charge. If battery cycling occurs use high cycle batteries.

2.3 Preventive Maintenance Procedure

There are six preventive maintenance procedures that can help preserve battery life. These six procedures are also the first steps you should take when diagnosing (i.e. troubleshooting) a problem in the vehicle's electrical system. The six preventive maintenance procedures are as follows:

1. Check cleanliness. If the battery rack is dirty, remove the battery cables first, then remove the battery from the vehicle. Wash the battery rack with a water and baking soda solution. Flush the case with water, and dry with a towel. If necessary, clean the battery post and cable terminal with a wire brush or a special terminal cleaning tool. Wash batteries with baking soda and water.

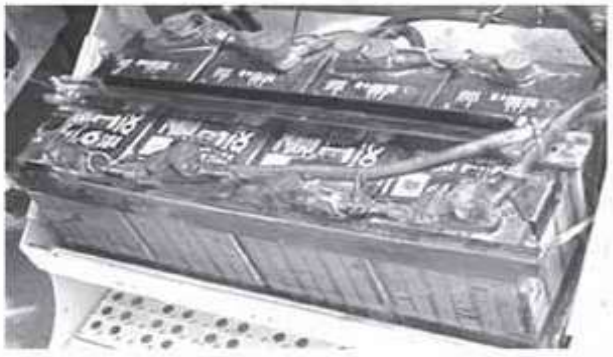

Figure 6: Battery hold-down brackets.

2. Check hold-down brackets. Make sure the brackets holding the battery to the vehicle's frame are secure. If the brackets are loose, tighten to manufacturer specifications.

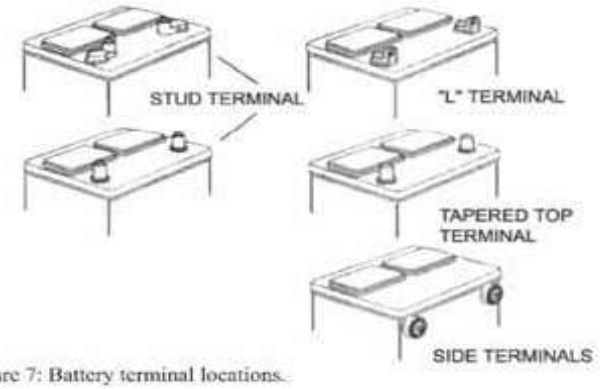

Figure 7: Battery terminal locations.

3. Check battery cables. Battery cable connections to terminal should be checked for corrosion and proper tightness, and cleaned and /or tightened as necessary. The cables themselves should be checked for swelling, cracking, or brittleness, cables should be replaced as necessary.

4. Check battery ground cables. The battery ground cables must be securely fastened to the alternator ground. Also be sure that the points where the cables are connected to the vehicle's frame or engine block are clean and secure.

5. Check battery case. The condition of the battery case often indicates whether internal component damage or loss has occurred. Telltale signs are swelling and cracking of the case.

6. Check fluid levels (only on non-maintenance-free types of batteries). If liquid in the battery is low, add clean soft water or distilled water only. Adding a premixed electrolyte solution will make the sulfuric acid too strong and cause the plates, separators, and case to deteriorate prematurely.

2.4 Diagnostic / Troubleshooting Procedures

When trying to find the cause of a problem in a vehicle's electrical system, you should always begin with the battery. **In performing any diagnostic procedure, refer to the safety information section in the Introduction section 1.6.**

It's critically important for each individual battery to be properly tested and fully charged. It's only then that you can move on to diagnosing problems with the charging or starting systems. A battery not fully charged will cause all other electrical systems tests to be inaccurate.