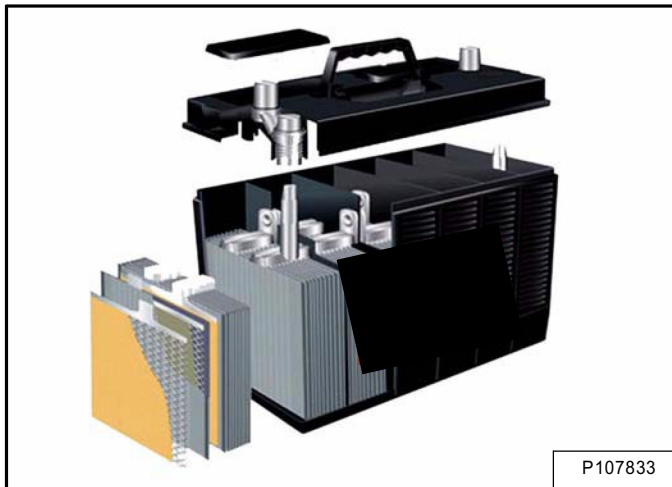


Figure 1



**[Figure 1]** Doosan brand batteries have many unique design features for use in Doosan machinery used in tough environments. Batteries are an important part of Doosan equipment and typically provide many years of trouble-free service with proper maintenance. This Service Letter covers important information for maintaining batteries in machine inventory, new stock and preparing batteries for service. These tips will improve performance, extend battery service life and identify warranty coverage requirements.

**NOTE:** The term “Maintenance-free” refers to a battery that normally requires no service watering during its lifetime of use. Proper testing, charging, and storage are important to maximize service life on all batteries.

### Procedure

Refer to the Operation & Maintenance Manual or Service Manual as necessary for details of procedures outlined below.

### Battery Charge Levels on New Machines

A key factor for long battery life is to maintain the charge level. The machine charging system is designed to maintain battery charge, not to fully recharge a severely discharged battery. On average, a machine needs to run for 15-20 minutes to recover from the battery drain at start up.

The most critical time to perform battery maintenance is when a machine is newly delivered to the dealership. DIPP strives to have the batteries in production machines fully charged at shipment. Occasionally, a machine may arrive at a dealer not fully charged because of the many start-ups during machine shipment.

The battery voltage is required to be checked upon equipment arrival at a dealership per the procedures on page 2 **[Figure 2]**. The measured battery voltage is to be recorded on the Arrival Condition Report (ACR) form and any battery found below 12.4 volts must be charged using a low charge rate to 100% charge. ***The ACR's need to be fully completed within 30 days of product ship date to be eligible for labor reimbursement on a battery warranty claim while in dealer inventory.***

Local climates may expose batteries in machine inventory to extreme hot or cold temperatures. ***Because of this, the battery state of charge in machine inventory should be checked every 30-60 days. This check is especially important in winter months to avoid battery freezing due to low charge.***

## Battery Testing

The first step in maintenance on an installed battery is to visually inspect for corroded terminals, broken posts, cracked or damaged cases, low electrolyte levels, missing or damaged vent caps or loose connections. Clean, fill with distilled or de-ionized water, or repair as required.

Figure 2

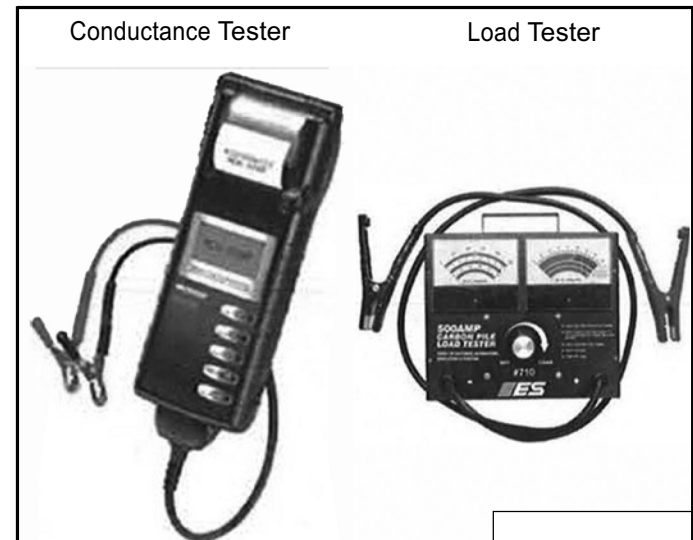


[Figure 2] The simplest and most common check to determine a battery's state of charge is to use a digital multimeter, or voltmeter (Item 1). A temperature compensated hydrometer test can also be used and will detect shorted cells.

A battery found below 12.4 volts must be charged to 100% charge per the battery charger's recommendation. An automatic charge is preferred to avoid a possible overcharge condition. To get an accurate reading after charging, **allow at least a 60 minute after the battery has been charged, or loaded, before rechecking the open circuit voltage.**

If the reading is less than 12.4 volts after the battery has been charged for several hours, test the battery using a conductance or load tester.

Figure 3



[Figure 3] Conductance testers or adjustable load testers are the most reliable tools for consistently determining if a battery is serviceable.

A conductance tester determines, **prior to charging**, the battery's ability to transmit current through its internal structure. This test can detect cell defects, shorts, and normal aging. Results will show measured battery rating (CCA) compared to the specified rating and indicate if battery is good, bad, or requires charging.

A load test accurately determines the battery's ability to deliver power needed for normal engine starting. A load tester applies a load (adjusted to 1/2 of the battery's rated CCA) **to a fully charged battery** for 10-15 seconds then measures the resulting voltage. When performing a 1/2 CCA load test for 15 seconds at room temperature (70F), results of 9.6 volts or higher typically indicates the battery is serviceable.

**NOTE: If a battery passes a conductance or load test but loses its charge rapidly when connected, verify everything on the machine is turned OFF and test for any unusual drain on the battery.**

## Battery Charging

A battery charger rated at 15 volts or less is recommended. A low, sufficient charge rate and adequate time is required to bring a battery to 100% charge, or 12.6 volts, rested open circuit voltage. Batteries should be charged at room temperature to avoid any under charge or over charge conditions.

**The charging process** reverses the chemical reaction of discharging, converting the lead sulfate and water back to the original materials. If the battery sits at a partially discharged state for an extended period of time, permanent sulfation occurs, which is irreversible.

After charging, again check the electrolyte level in all cells to ensure the proper level.

**Several types of battery chargers are available:**

### Constant Current (Manual) - Not Recommended

Using this type of charger makes the battery vulnerable

to overcharging which causes gassing ('boiling').

### Constant Current (Automatic) - Low Cost and Good for Most Applications

Constant current charger has voltage sensing logic that turns charging on and off as needed. Typical low current examples that use this technology are referred to as 'Battery Maintainers' or 'Trickle Chargers' and have reverse polarity protection as a typical feature.

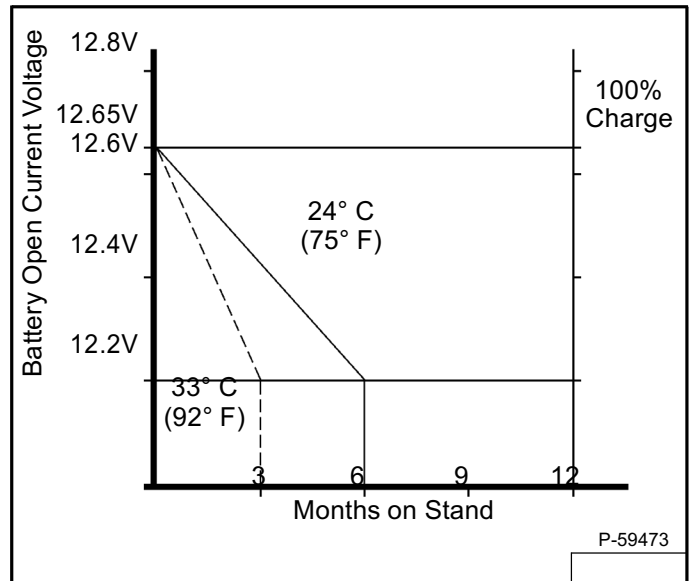
### Constant Voltage - Excellent Operational Features

The charging voltage and internal battery resistance remain constant. As a result, the charging current decreases over time as the charge level increases. Charging is complete when the current doesn't change over a 1 hour period. This type of charger is most similar to a voltage regulated charging system (alternator) in a machine and prevents gassing.

Other charger types may combine these types of technology and some may have battery and electrical system testing capability (diagnostic chargers).

## Battery Self-Discharge Over Time

**Figure 4**



**[Figure 4]** All batteries will slowly lose charge when not in service. This is known as self discharge and will result in reduced performance and service life. The rate of self-discharge increases at higher temperatures.

When the batteries become discharged, a boosting charge should be administered regardless if the batteries are to remain in stock or are being prepared for sale. This boost charge will normally be required every 4-6 months of storage to keep the battery above 75% charge.

Many products have features that require battery power even when the machine is not being used. This also contributes to battery discharge.

## Battery Stock Maintenance

Store batteries under roof, off the floor or ground and in a cool, dry, well-ventilated area that is separated from incompatible materials and from activities that may create flames, spark, or heat. Avoid storing batteries in high 38°C (+100°F) ambient conditions. High temperature increases the battery chemical reaction which will shorten shelf life and accelerate grid corrosion. Check the state of charge on batteries stored over 3 months, and keep batteries above 75% charge to avoid premature sulfation that causes loss of capacity and early battery failure.

Battery stock must be rotated on a strict, **first-in, first-out** basis. **In order to accomplish this, a proper inventory battery maintenance program should be established.** Date codes are stamped on each battery to aid in rotating the batteries for retail.

Battery racks provide the best method for storing and insuring the proper rotation of batteries. Racks should be marked on the front and rear so the same type of battery will go in the same rack every time. If racks are loaded properly, the oldest battery of a particular type will always appear in the front.

Batteries used for display purposes and battery stock must not be neglected. They should be boosted whenever the battery open circuit voltage drops below 12.4 volts.

### Battery Freezing

VOLT READING 27° C    -18° C (80° F)    (0° F)		BATTERY CHARGE	BATTERY FREEZE POINT
12.65	12.45	100%	-59° C (-75° F)
12.45	12.25	75%	-48° C (-55° F)
12.24	12.04	50%	-37° C (-34° F)
12.06	11.86	25%	-27° C (-16° F)

The chart above shows the temperature that electrolyte in batteries, at various states of charge, begins to freeze or ice crystals begin to form. The electrolyte does not freeze solid until a lower temperature is reached. Solid freezing of electrolyte in a discharged battery will damage the plates and crack the container. Batteries in which the electrolyte has frozen must be replaced and properly disposed of.

If a battery becomes severely discharged, the electrolyte can freeze in extreme conditions below -18° C (0° F). Since temperature affects voltage readings, batteries should be kept at least 75% charged to prevent the electrolyte from freezing.

### Preparing a Battery for Retail

Always charge and load test a suspect battery to determine if replacement is necessary.

If a replacement battery is removed from storage to be installed into service, first check the state of charge. Then check the electrolyte level in all battery cells. If required, add additional distilled water or de-ionized water to bring all levels to the bottom of the vent wells. Maintenance free batteries are clearly labeled. Do not open the vent caps on maintenance free batteries.

Keep the battery vents closed while charging the battery. Charging produces ignitable gases that must be routed through the battery vent cap or plug. Use a good charger.

### Battery Maintenance after Retail

A battery is a perishable item that requires periodic maintenance. With a reasonable amount of care, battery life can be significantly extended. Neglect and abuse will result in shorter battery life.

A routine check of the battery can be made during periodic fueling stops or service intervals such as engine oil changes. A visual inspection should include defective cables, loose connections, corrosion, cracked cases, loose hold-downs and loose terminal posts. Keeping the battery and connections secure and clean will improve the service received from the battery.

If the battery electrolyte requires top-off while in service, add distilled water or de-ionized water. **Do not add acid.**

### Battery Service During Machine Storage

If storing a machine for an extended period of time, remove the battery. Verify the correct electrolyte level and fully charge the battery. Store the battery in a cool dry place above freezing and boost charge periodically.

Operation & Maintenance Manuals include information on battery maintenance and proper long term storage. Review this with your customers to promote battery life and customer satisfaction.

For more information visit the Battery Council International web site at <http://www.batterycouncil.org>

This letter is provided as technical information only and does not alter warranty coverage.