Historical Background: Charging batteries in a float/maintenance mode has been standard practice for decades when batteries have been used for standby power applications, such as telecommunications, UPS (Uninterruptible Power Supply), and emergency lighting. Also, the U.S. military has invested literally billions of dollars in developing standby battery charger systems for uses in countless weapon systems: ships, aircraft, ground vehicles, etc. The simple definition of float/maintenance charging is that voltage is continuously applied to the battery terminals. The amplitude of that voltage varies between 0.2 volts and 0.6 volts above the rest state voltage of the battery when it is fully charged. The purpose of continuous float/maintenance mode charging is to maintain the battery in a fully charged condition so that when it is called into service, it will be able to deliver its full charge capacity. Until recently, the most commonly used battery chemistry in sophisticated military weapons systems has been NiCd, rather than lead acid. Nevertheless, the concept of continuous float/maintenance charging has been around for a long time.
In the early 1990's, engineers and product managers at Deltran corporation successfully applied this same battery charging concept to engine start batteries. The original Battery Tender battery charger was marketed for use in the motorcycle industry. After many years of continued success, the Deltran charger product offering was expanded to include many higher-powered chargers, in different physical packages, both portable and permanently mounted, and with different output charge voltage and output charge current configurations. The Battery Tender Plus battery charger is an improved version of the original product. Its design is optimized for use with sealed, gas-recombinant, absorbed glass matte, lead acid batteries. It has been on the market since 1991.

Technical Discussion Categories: There are basically 2 categories of technical issues that need to be discussed when debating the merits of float/maintenance charging.

1) What observable characteristics of the battery support and detract from using continuous, float/maintenance charging?

2) What observable characteristics of battery chargers support and detract from using continuous, float/maintenance charging?

1) A. Battery Voltage vs. SOC: In the first category, batteries develop a voltage that indicates how much charge is available for use. The relationship between battery terminal voltage and State Of Charge (SOC) is reasonably linear. For a 12-volt, lead acid battery, that relationship is defined by a 1.5-volt change in terminal voltage that represents the entire SOC range from 0% to 100%. Also, that voltage must be measured when the battery is in a state of rest (the battery terminals are open-circuited), neither being charged nor discharged. A fully charged 12-volt battery will have a terminal voltage of approximately 12.9 volts and a fully discharged (0% SOC) battery will measure 11.4 volts at its terminals. Therefore, a change of 0.15 volts represents a 10% SOC difference.

1) B. Internal Battery Losses: All lead-acid batteries develop and store charge as a result of an internal chemical reaction. There are 2 primary internal loss mechanisms. The first is a result of the chemical interaction between the internal battery elements. That interaction is continuous and it is affected by temperature. It is also affected by whether the battery is being charged, discharged, or in a state of rest. In all 3 situations, the battery terminal voltage will change. In one sense, the battery is never truly in a state of rest, rather, its terminals are connected either to a charger (being charged), or to a load (being discharged) or the battery terminals not connected to anything (the terminals are open-circuited, or in a "state of rest").

The second primary internal loss mechanism is due to the physical interconnections between the chemically interacting elements and the electrically conductive paths to the battery terminals. This second loss mechanism is usually called the internal resistance of the battery. When the battery terminals are open-circuited, that is, not connected to either a battery charger or a load, only the internal chemical losses influence the battery terminal voltage. When the battery is being either charged or discharged, both the chemical losses and the internal battery resistance influence the battery terminal voltage. The simplest battery model for electrical circuit analysis is an ideal battery in series with a resistor. The voltage of the ideal battery is the open circuit voltage that represents SOC. The value of the series resistance is the battery internal resistance, typically measured on a fully charged battery at a frequency of 1000 Hertz. That resistance value is usually in the 5 to 10 milliohm range. More sophisticated battery models account for the fact that the internal resistance is not constant over the range of SOC. Even more sophisticated models include a complex impedance (some combination of resistance, inductance, and capacitance) in parallel with the ideal battery. For example, because of the construction of lead acid batteries, the equivalent electrical capacitance is in the range of several tens of thousands of Farads. For this reason, specifying a ripple component of output voltage on a battery charger when it is connected to a battery is somewhat futile because of the tremendous voltage-filtering characteristic of the battery's equivalent electrical capacitance.

Since the internal resistance of the battery is very small, its impact on the value of voltage measured at the battery terminals is only significant during high rate (lots of current) discharges and charges. When the battery is being discharged, the battery terminal voltage is less than its open circuit value. Conversely, when the battery is being charged, its terminal voltage is more than its open circuit value. The difference between the voltages is calculated by the product of the charge or discharge current and the internal resistance. In float/maintenance charging situations, the charge current is usually very small, so that the difference between the open circuit voltage and the actual battery terminal voltage is also small.

2) A. Battery Charger Output Voltage vs. AC Line Voltage (Output Voltage Regulation): This one aspect of Power Supply (battery charger) Line Regulation is very important because the output voltage of the battery charger must be in a certain range, and it must not deviate significantly from that range, otherwise a battery can be overcharged, or it can be undercharged. Fortunately, in the United States, the national AC power grid, the AC power distribution system, is very stable. Therefore, battery charger line regulation characteristics have less impact than they would when the AC power, particularly the AC line voltage varies significantly. In general, one could say that the simpler the construction of a battery charger, the more likely it is to have larger percentage line regulation characteristics. The larger the percentage, the more the output voltage will vary with the AC line voltage.

2) B. Battery Charger Output Voltage vs. Temperature (Temperature Compensation): This battery charger characteristic probably has more influence on the battery than line regulation. Even if a battery is kept at its ideal float voltage, and it that ideal voltage is compensated properly for temperature, an increase of only 7 °C to10 °C can cut the battery life in half, assuming that the higher temperature remained for the entire observation period. Short-term fluctuations in temperature have little impact on battery life, unless the temperatures are extreme. In general, cold is good, hot is bad, very cold is better (but too cold can be worse), and very hot is worse.

At the extreme cold end, bad things can happen as well, but those bad things are just dramatic reductions in the battery performance. At the extreme hot end, while the battery is charging, it can emit dangerous gasses. The ideal temperature compensation range for lead acid batteries is typically in the range of 2.5 to 4.0 millivolts per 2-volt cell, per degree Centigrade. The temperature compensation coefficient is also negative, meaning that the change in charging voltage is in the opposite sense as the change in temperature. If the temperature goes up, the charging voltage comes down and vice-versa.

Arguments For and Against Continuous float/maintenance Charging: From the preliminary background on batteries and chargers, positions can be taken for or against continuous float charging.
The main argument against continuous float charging is that the battery will: a) be undercharged, or b) be overcharged, and / or c) be permanently damaged as a result of a) or b).

The main argument for continuous float charging one of convenience in that it is better to have the battery fully charged when you need to use it.

An automatic, well-regulated, temperature-compensated charger can keep the battery fully charged and at the same time minimize the risks of long-term damage to the battery due to either under-charging or over-charging. The alternative is to let the battery internal losses run their course, which for most batteries means that they are fully discharged within a few months. If you forget to recharge them periodically, and they become severely over-discharged, even due to only internal losses, the plates will become severely sulfated. For many batteries, that means that they are permanently damaged. Recommendations for Using the Battery Tender Plus in Continuous Float Mode Charging: The line regulation characteristics of the Battery Tender Plus are excellent; less than 1% for line voltage between 115 VAC and 125 VAC. This charger is temperature compensated and it has a special charging algorithm optimized for sealed, gas-recombinant, AGM, lead acid batteries. Numerous motorcycle owners have reported to Deltran over the years that their batteries have lasted 3 years or more. Before using the Battery Tender charger, they would have to replace their batteries as often as every 6 months.