

# East Penn's Recommended Evaluation Method and Resource Guide for Motive Power Charging

## MOTIVE POWER BULLETIN

Today's motive power fleet has more options for charging than ever before. Along with these additional choices comes an added responsibility to make sure these methods are best suited for each operational application. Traditional methods such as Conventional charging or newer ones like Fast or Opportunity charging can be an invaluable tool if used correctly in the right operation. Claims of substantial cost savings and productivity benefits associated with these techniques should be carefully evaluated and researched before determining the best method of charging.

As a leading supplier of Motive Power products with over 60-years experience in the battery industry, East Penn feels a responsibility to our agents, sales network, and ultimately our customers, to ensure these faster methods of charging are implemented in the proper application that best serves our customers' motive power operations.

In order to determine whether Conventional, Fast, or Opportunity charging is right for an operation, it is imperative to compare the differences of each charging method.

### **What is the difference between Conventional, Fast, and Opportunity charging?**

The main difference between charging methods is the rate at which the battery is charged. Fast and Opportunity charging charges a battery at a higher rate than Conventional charging. Fast and Opportunity chargers deliver a higher charging rate when the battery is at 30 to 80 percent state of charge because the battery's charge acceptance is higher. This significantly reduces charging time. Below is a chart listing the various charging methods and starting rates:

Charging Method	Charging Starting Rates
Fast *	40 - 60 amps per 100 AH
Opportunity	25 - 35 amps per 100 AH
Conventional	13 - 20 amps per 100 AH

*\* The maximum start rate recommended by East Penn is 40 amps per 100 AH*

Fast and Opportunity charging are very similar. The biggest difference between the two methods is the start rate of the chargers. They both require that the battery is charged during break periods and downtime while still in the material handling equipment.

Conventional charging has a lower charging start rate. It is designed to fully charge the battery after it is discharged to 80% of its rated capacity. The discharged battery is replaced with a fully charged battery allowing the lift truck to remain in use.

### **What is the right operation for Fast, Opportunity, or Conventional charging?**

It depends! Each operation should be carefully evaluated before any charging method decisions are made. Below are some general operational characteristics that can help determine if Fast, Opportunity, or Conventional charging is right for the intended application.

#### **Fast Charge Compatibility:**

- Operation is either 2 shifts, 8-10 hours per shift, or 3 shifts, medium duty (2-4 hour run time per shift) using 2 batteries per truck with Conventional charging.
- User perceives significant value in reducing spare batteries and associated battery storage, charging, and change-out equipment.
- Battery power requirement for a 24-hour period will not exceed 1.5 times the 80% rated capacity of the battery.
- Minimum 6-hour charge time available per 24-hour period.
- Sufficient charge time for weekly full charge and equalize charge.

#### **Opportunity Charge Compatibility:**

- Operation is an extended single shift, 10-12 hours, or 2 shifts with a light to medium workloads, five to six days per week.
- User perceives significant value in reducing spare batteries and associated battery storage, charging, and change-out equipment.
- Battery power requirement for a 24-hour period will not exceed 1.25 times the 80% rated capacity of the battery.
- Minimum 12-hour charge time available per 24 hour.
- Sufficient charge time for weekly equalize charge.

#### **Conventional Charge Compatibility:**

- Single and multiple shift, light to heavy-duty operations, where a battery is used for one shift
- Material handling equipment is utilized 80% or greater per operation shift
- Material handling equipment with attachments requiring excessive battery power such as large clamps, slip sheets, and extended mast heights
- Extreme environmental operations such as freezer or high temperature

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## ***If you are currently using Conventional charging and are considering a change, what critical questions need answers when evaluating Fast or Opportunity charging systems?***

If an operation matches the Fast or Opportunity compatibility requirements previously mentioned there are still many critical questions that should be considered when evaluating a faster charging system. It's important to note that all operations can work with Conventional charging as long as there are sufficient batteries and chargers available to support each operating shift.

### **1. Will a Fast or Opportunity charging system provide sufficient power for peak demands?**

Batteries on a Fast or Opportunity system are seldom completely charged. Skipping breaks or downtime needed for charging is not an option, and will result in an ampere-hour deficient battery. These batteries will not perform at rated capacity or provide acceptable service at this lower state of charge.

### **2. Budget available for replacement batteries?**

Additional funds will need to be allocated for more replacement batteries over a shorter period of time. Immediate productivity needs should be compared to the cost of more replacement batteries to determine the most cost effective charging solution.

### **3. Will there be time saved at down periods like break time?**

Claims of shorter downtime at break periods are extremely relative to the operation. With Fast and Opportunity charging, the time the material equipment operator takes to park the equipment, connect the battery to the charger, and walk to the break area must be examined. Although a battery change-out may seem longer, a properly designed and installed battery side extractor and racking system will require only 2-3 minutes. A Conventional charging battery change-out can actually take less time depending on the location of the park and charge location within a Fast or Opportunity charge operation.

### **4. What are the additional costs from the A/C power provider?**

There are additional cost considerations with new electrical installation upgrades to provide sufficient A/C power service. In addition, A/C power usage will increase if done during costly peak demand periods resulting in higher power utility costs.

### **5. What will it cost to buy new batteries and upgrade your lift trucks and safety equipment?**

Batteries designed for Fast or Opportunity charging include modifications to improve power conductivity, charger communication, and sensors for electrolyte and thermal management as shown below. These modifications can add hundreds of dollars to the cost of each battery.

- Dual cables
- Double stacked intercell connectors
- Copper inserted cell posts (15 plates or less)
- Battery monitor device that communicates with charger
- Single-point watering system

- Electrolyte level and temperature sensors
- Vented battery tray design
- Forced air cooling systems

Material handling equipment upgrades may also add significant cost to the equipment:

- Mounting brackets for connectors
- Additional jumper cable leads
- Cooling fans on battery compartment

New safety gear required at each park and charge location is also a cost that cannot be ignored:

- Eye wash stations
- Protective gear
- Fire extinguisher
- Ventilation equipment

### **6. How much extra space is gained with Fast or Opportunity Charging?**

Many operations that switch to Fast or Opportunity charging eliminate their room dedicated for battery charging to save space. They eliminate the need for spare batteries and change-out equipment, which can also save considerable space. In most cases, however, a designated battery area with extraction equipment is still required to facilitate battery repairs, maintenance, or change-outs. The cubic space of the battery charging room versus the cubic space of the park and charge locations should also be considered.

## ***What is the best way to evaluate charging method compatibility?***

East Penn has developed a Charging Evaluation Process and Power Solution Development method. With this evaluation process, East Penn works step by step with the customer to determine the optimal power solution maximizing satisfaction, performance, and extended value.

### **Evaluation Steps for Existing Installations:**

**Step 1:** East Penn representative and/or agent meets with the customer to complete a site survey, and evaluate critical factors such as fleet size, time for charging, and additional infrastructure required.

**Step 2:** Forklift data is recorded. Each application involved is monitored for one week with an EPM approved collection device.

**Step 3:** Data is sent to East Penn or charger manufacturer for analysis

**Step 4:** East Penn representative and/or agent develops the Return of Investment (ROI) and proposal for customer.

For new operations, contact East Penn for a complete new installation charging compatibility evaluation.

# What are some generally asked questions about Fast and Opportunity charging?

## What are the operational implications of charging at a higher rate?

**Initial Cost:** Initial charger investments may cost up to 5 times more than a conventional charger operation, especially if the charging system utilizes a dedicated charger for every battery.

**Infrastructure Change:** Once committed to the Fast or Opportunity charge process, it can be very difficult to transition back to Conventional charging or terminate the program. Additional investments and infrastructure changes can be costly including supplying adequate AC power, a water source for an eye wash station(s), and ventilation equipment to meet OSHA and safety requirements in the park and charge location(s). The elimination of a room or area dedicated for battery charging to save space may seem beneficial. However, once that space is occupied it can be very difficult to revert back to a designated battery area.

**Battery Life:** Battery life in a Fast or Opportunity charge operation will be shorter than in a Conventional charging operation. In a Fast or Opportunity charge operation, the life of the battery will depend upon Ampere-Hour throughput, not length of time or traditional cycle life. Conventional charge battery life is measured in cycles, typically one cycle per day, 300 cycles per year, 1,500 cycles over 5 years.

**For example, a Conventional charge 1,000 AH battery, discharged to 80% of rated capacity will provide 1,200,000 AH throughput over a 5-year period. The same battery in a Fast charge operation (not exceeding the daily AH throughput of 1.5 times the 80% rated capacity of the battery) will reach a total of 1,200,000 AH throughput in 2.7 years. An Opportunity charge operation (not exceeding the daily AH throughput of 1.25 times the 80% rated capacity of the battery) will reach a total of 1,200,000 AH throughput in 3.3 years.**

**Operational Alterations:** An additional consideration is a possible alteration to employee breaks, lunch periods, and staggered shifts. These downtimes are needed for recharging and have to be at the right time to maximize battery productivity and operational needs.

Another alteration is a change in lift truck usage. In Conventional charging, a spare battery allows the truck to remain in use while the battery is charging. In a Fast or Opportunity charging, the battery is being charged while remaining in the truck, and it cannot be used while charging. In some instances, this could have a significant impact on the allocation efficiency of material handling equipment resources.

## What are some key practices for a Fast or Opportunity charge operation?

**Key 1:** The East Penn agent salesperson, customer, and Fast/Opportunity charge supplier have worked together to

measure the battery power requirements for each forklift type, time to recharge the battery, and allocate sufficient time for a weekly equalize charge.

**Key 2:** Battery operating electrolyte temperature range between 50°F (10°C) to 125°F (52°C) during daily operation.

**Key 3:** Daily battery AH throughput is 1.25 to 1.5 times the 80% rated capacity of the battery being used.

**Key 4:** Batteries should receive a full recharge on a daily basis and an equalized charge every week. If the battery can only be recharged to a minimum 80 percent state of charge on a daily basis, then weekly full charge along with an equalize charge will provide acceptable service life.

**Key 5:** Charger start rates should be 25-60 amps per 100 AH. Higher start rates will significantly shorten battery life. The maximum start rate recommended by East Penn is 40 amps per 100 AH.

**Key 6:** Batteries designed for Fast or Opportunity charging include modifications to improve conductivity such as copper inserted posts, dual cables, double stacked intercell connectors for best performance and longer life.

**Key 7:** A standard gravity battery design (1.290 specific gravity) should be used in a Fast or Opportunity charging operation to optimize battery life. **We do not recommend using batteries with full charge specific gravity in excess of 1.290 and/or product designed for reduced watering or maintenance applications.**

**Key 8:** Battery trays should have air gaps where possible to dissipate additional heat from higher charging rates.

**Key 9:** User discipline and willingness to connect to the charger as prescribed.

**Key 10:** Continuous measurement of AH throughput.

**Key 11:** Proper battery maintenance in accordance with the East Penn Industrial Battery Service Manual.

## What types of chargers are suited for high rate charging?

The below chart shows a list of chargers that are suited for higher rate charging applications. This chart is solely for reference. Only a careful evaluation of an individual operation can lead to a determination of which charger is right for a specific application.

Chargers for Fast or Opportunity Charging
AeroVironment/PosiCharge
AMETEK
Applied Energy Solutions
Edison – Minit Charge
Power Designers
Stanbury

## What types of monitoring and recording devices are suited for high rate charging?

The higher the charging rate, the more critical it is to monitor the charging process to prevent permanent capacity loss. In efforts to preserve battery life, Fast and Opportunity charging incorporates a method of monitoring battery electrolyte temperature and/or internal resistance and adjusting charging current as necessary.

Although these monitoring devices can have a very positive impact on battery life and performance in a Fast and Opportunity charge operation, the additional cost associated with monitoring devices is a significant factor in an initial investment. It is a good practice to match the monitor device with the charger manufacturer for best compatibility results. It's important to note that many chargers work best with certain battery cable sizes, connectors, connector mounting brackets, single point watering systems, electrolyte temperature sensors, connector manufacturing preferences, and jumper cable assemblies. Careful consideration must be practiced with the purchase and installation of these various items to avoid costly mistakes.

The below chart shows a list of battery Ampere-Hour throughput and temperature compensation devices recognized by the coinciding Fast and Opportunity charge manufacturers.

Charger Manufacturer	Battery Module Name
AeroVironment/PosiCharge	BMID
AMETEK	BID
Applied Energy Solutions	BIT
Edison - Minit Charge	BICC
Power Designers	PowerTrac
Stanbury	*

*\* Stanbury does have temperature compensation but only when ordered; typically this is only for sealed batteries. They are in the design process of an ampere-hour throughput device.*

## Why take the time to carefully evaluate charging methods?

Organizations can experience substantial cost savings and productivity benefits with the right type of charging process. However, the wrong application can lead to a financial disaster for a motive power operation. It is critical to know all of the facts and implications before making any type of decision; then and only then can it be determined which charging method will meet operational needs.

The safest approach is to let East Penn and its extensive agent network, an organization with years of industrial battery experience and customer motive power application success, evaluate an operation to help determine which charging method matches best.

## Glossary of Terms

**Ampere-Hour Throughput:** Accumulated Ampere-Hour recorded during Discharge and/or Charge over time.

**Amps/100 AH:** Charger current output measured in amperes per 100 AH rating of the battery being charged.

**Conventional Charge:** Charger start rate nominal 16-20 amps/ 100 AH. Usually a 7-8 hour uninterrupted charge cycle.

**Electrolyte Temperature Compensation:** Electrolyte temperature sensor installed in a battery cell to monitor and record electrolyte temperature and communicate with the charger control to reduce or increase charge current and charge time depending upon electrolyte temperature above or below 77°F/25°C.

**Fast Charge:** Charger start rate nominal 40 amps/ 100 AH or higher. Battery S.O.C. maintained between 30-80 percent by charging battery in the truck during down periods such as breaks/lunch/dinner time, and between shifts. One battery per truck. Usually 2-3 shift operation.

**Opportunity Charge:** Charger start rate nominal 25-35 ampere/ 100AH. Battery S.O.C. maintained between 30-80 percent by charging battery in truck during down periods such as breaks, lunch/dinner time, and between shifts. One battery per truck. Usually 1-2 shift operation.

**S.O.C.:** Battery state of charge.

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