50 Answers
for the
Most Frequent Comments on Fast Charging

August 2006

1. It's too expensive.

- Some customers compare only the cost of a conventional charger to a fast charger and subsequently form this quick conclusion. However, when qualified customers (those that have a moderate to high daily energy use and change batteries once per shift or more) are told of the change in work process that occurs and the resultant elimination of battery changing equipment, apportion of the battery inventory, increase of productive time and increase in safety, the prospect becomes more open to proceeding to the next step of a more detailed assessment of costs and savings. Most prospects are amazed to see how much cost is incurred with their battery changing work process.

2. Fast charging is only for large fleets.

- This myth began with the coincidence that the first commercial users of fast chargers happened to have large fleets. Hundreds of site evaluations have shown that there is no correlation between fleet size and the ability to use Minit-Charger economically. What has been correlated is that the amount of energy through the fleet (amount of daily amp-hrs used and returned to the fleet) is an indicator of potential financial success using fast charging. There are many smaller fleets (as small as 2 or 5 trucks) that use their trucks just hard and frequently as large fleets and benefit from using Minit-Charger.

3. All fast chargers are the same so I will simply buy the lowest cost units.

- A key feature about a fast charger is that it must successfully provide the highest safe charge rate the battery can handle. Head to head demonstration tests against all major manufacturers and others demonstrate that conclusively that all fast chargers are NOT the same. Significant differences in performance exist between manufacturers.
- Fast chargers may be categorized as Temperature Compensated IVI; standard IVI or use of a real time adaptive algorithm as used by Minit-Charger.
- Minit-Charger's battery mounted BICC or BDC senses the internal workings of the electrochemistry of the battery as charging proceeds. This allows a real time signal to the charger power section to output

the maximum safe charge current rate appropriate for the battery's condition. Hence the phrase used by Minit-Charger: "Maximum safe charge rate." Because of the fail safe control mechanisms built into the system, Minit-Charger is not limited to arbitrary "max charger rates of 25 or 40 amps output per 100 amp-hr battery capacity" overrides found in competitor fast chargers.

- Temperature compensated chargers primarily use a heat sensing transmitter to "fold back" the charge rate after the battery is already exhibiting rapid temperature rise from a charge rate that is beyond what the battery can accept. To avoid extreme thermal conditions in case of failure, these chargers are typically limited to a maximum of 40 amps output per 100 amp-hrs of battery nominal capacity. (Note this can result in only 306 amps from a 500 amp advertised charger for a 765 amp-hr battery!)
- The simplest form of control is the standard IVI method. These are generally identified by having no on-board battery module or communication between the battery and the charger. When coupled to an oversize power section to enable large amp rate outputs, this approach has been observed to result in instances of extreme overcharge and resultant battery damage. (This is the reason why, for decades, the industry has not condoned "fast" charging until the advent of chargers with better charge control methods.)
- There are other charge control aspects that define differences in competency in fast chargers available today. How "destratification", "full charging" and equalization are treated are equally important in assuring long battery life. Only Minit-Charger includes patented destratification methodologies and proprietary full charge and equalization programs. All of these Minit-Charger features are integrated to work automatically without the need of operator intervention. And only Minit-Charger's adaptive approach provides significant charge rate advantage as battery conditions change with age.

4. Sequential chargers do not return enough charge during break periods because some trucks might not get charged.

- Minit-Charger's patented sequential charging is used with staggered breaks in over 80% of these multi-station applications. In this sequential – staggered break operating mode every truck gets charged every time the truck is connected. Coupled with Minit-Charger's patented charge control, the maximum safe charge return is delivered each and every time. Full charging and equalization during off duty times is also automatically accomplished.
- During early in the development of Minit-Charger, single station (dedicated), parallel and sequential charging were all evaluated from the perspective of the impact of multiple high power chargers being connected to a typical facilities power grid. This intensive study

determined that sequential charging used with and without staggering would provide the lowest demands on the facility while maintaining high states of charge in the trucks. Subsequently, Minit-Charger patented the sequential charging technology used today in a large variety of customer applications.

5. IGBT chargers have better charge control.

- Insulated Gate Bipolar Transistor refers to a type of power section design used in some newer fast and conventional rate chargers. Note that this is strictly related to that component of the charger that has to do with the bulk power output and not with the control of the charger's output. Hence, the use of IGBT's in a power section contributes nothing to the charge control. It's the charge control section of a charger that determines whether a battery is being recharged at battery safe rates to ensure high Coulombic efficiency and long battery life.

6. IGBT chargers are more efficient.

- Several separate and measurable efficiencies combine to establish the overall efficiency of a fast charger. These are a) Coulombic efficiency, and b) AC / DC power conversion efficiency.
- IGBT and MOSFET based chargers may have better power factors than SCR or ferromagnetic chargers but the differences between these have nothing to do with efficiency.
- Ferromagnetic based power section designs only operate over narrow output parameters. This limitation makes this type of power section the least suitable for fast charge applications.
- The Minit-Charger product line is comprised of chargers that have power sections selected to deliver a variety of benefits for the customer depending on application. Hence, Minit-Charger continues to use IGBT, MOSFET and SCR technologies to provide a choice of options to allow selection of what may be best suited for the customer on the basis of performance, cost and field serviceability.

7. I've heard that battery life is reduced to only 2 or 3 years instead of the usual 5 to 6 years.

- Eight years of fast charge battery experience in moderate and high energy throughput environments reveal that battery life has more to do with the amount of amp-hrs in and out of the battery than the unrelated phenomenon of calendar time. The rate of use of the active material is what determines the calendar longevity. Hence, a battery used every shift of every day will correspondingly last less calendar time than a battery, in the same facility and the same service, used in only one shift per day. Therefore, all other things being equal, a battery used in a daily 2 shift application should last about half the time of a battery used in only one of those shifts. Either way, the value delivered to the

customer by the battery is the same despite the difference in calendar time.

8. Shouldn't I have "One charger and one battery per truck" to assure the trucks get enough charge.

- A proper evaluation of fleet needs will typically reveal several options (multi-station or single station) that can be used to fast charge your fleet. Selection of a fast charger includes consideration of a variety facility and fleet needs. Only after a proper evaluation can the best solution be identified. Those that make flat statements such as that posed above are usually fast charger suppliers who have not invested in development of a complete product line and therefore cannot offer a choice of solutions.

9. My operators won't like it.

- Some people initially resist change in the workplace. However, experience in application has shown that operators much prefer "connecting up" as opposed to hassling battery change out (whether they do it or a battery technician does the change). Operators enjoy the fact that they have an organized place to park their truck to connect to the changer at break and can more easily find the truck and avoid the traffic jam at shift changes. Facilities using staggered breaks provide for a less crowded break room. Operators that are on productivity incentive programs realize they have more control over their work effort and can make more incentive money with fast charging.
- Unions may resist change. Automotive industry unions were less certain about fast charge until an intensive study at a major automotive manufacturer proved that reduction of forklift accidents and injuries was a significant benefit. The result of eliminating pedestrian and other forklift accidents while racing back to the battery room to get a battery change was a major improvement in plant safety.
- "If an operator can fill his car up with gas from the pump, he has all the skills needed to recharge his forklift at the Minit-Charger®!"

10. I won't realize the expected productivity gain.

- Fast charging eliminates wasted time traveling to and from the battery change area and the time to change the battery itself. Furthermore, by having the trucks park at charge stations, connected to the fast charger during breaks. This allows operators to easily find their assigned or favorite trucks at end of shift or break. All of this translates into minutes of extra time available to begin or continue work.
- The math is something like this: Say an example 8 hr shift in a medium size facility typically requires lift truck operator to change his battery once during the shift. To do this, say the operator has to

suspend work, travel 3 minutes to the change area, change the battery in 9 minutes and travel 3 minutes back to the work area. Total time from work is 15 minutes for a battery change. Say this operator's fully burdened wage rate is $18 per hour. Lastly, say the facility works 2 shifts per day, 269 days per day and there are 25 lift trucks in the facility. The resultant potential productivity gain (savings) from elimination of battery change time equals: $58,500 (or 3,250 labor hours) annually for the fleet. If diligent employees are managed to use the time made available by eliminating battery changes, significant savings can be had. This may translate into higher output from the facility (more SKU's received / shipped) OR a potential reduction of one to two lift trucks and operators to perform the same amount of facility transactions.

- What about the time it takes to go to the fast charger and connect? In nearly all cases, this occurs while the employee is heading to break room anyway so travel time will be consumed with or without fast charging. The time to connect is about a minute and therefore is not material.

11. Battery suppliers don't really endorse fast charging and will cancel warranty if there are any problems.

- Not true! Tens of thousands of trucks are fast charging in North America today. The fast charge market is large and the rate of fast charge growth is about 9% per year as forecasted in a survey conducted by the Industrial Truck Association. Many battery manufacturers see the need to service this growing market in order to retain market share. Hence, battery manufacturers stand behind their warranties.
- Every Minit-Charger includes Minit-Track, the trend setting proprietary data and information system that allows customers and battery manufacturers to see how the truck – battery – Minit-Charger system has been used and how it has performed. Mint-Trak graphically displays any divergence from intended system use and can easily identify any corrective measures needed.

12. The extra power circuit and panel cost eliminates any savings.

- Costs for this subject include a) the circuits to each fast charger b) the power available from the panel and c) any changes to the incoming available power provided by the utility substation. Significant differences can be seen between fast chargers' impact on this topic.
- Circuit Installation Cost - Multi-station fast chargers compared to single, dedicated, fast chargers have a lower cost advantage by virtue of needing fewer circuits.
- Power availability - Minit-Charger was designed with the typical availability of power within a facility. Existing warehouses and DC's typically devote about 25% - 30% of their power to conventional battery

Conventional chargers require 20-30 amp breaker (2 chargers=40-60)

- changing and charging. In a majority of cases, Minit-Charger's multi-station systems allow for a lower connected load while keeping all trucks charged by use of staggering or full sequential charging. In contrast single station chargers require a large connected load by virtue of every charger need its own full load circuit. Similarly, parallel chargers use much higher kW rated power sections to fulfill their claim of being able to charge all trucks at the same time. In contrast, manufacturing facilities such as automotive plants have large amounts of available power with charging performed when the power-hungry assembly line is stopped on break or otherwise down. Hence, some fast chargers have become specialized in automotive use but run into power availability problems in non-manufacturing facilities.
- Will these costs eliminate savings? In the absence of utility substation work, most customers continue to see significant life-cycle savings despite having to perform some infrastructure work. Minit-Charger multi-station fast chargers were designed for typical warehouse and DC applications. When compared to single (dedicated) fast chargers, Minit-Charger has a lower cost advantage by virtue of needing fewer circuits. Similarly, Minit-Charger multi-station chargers operated in staggered mode or sequential mode demand much less power than parallel fast chargers.

13. If a multi-station charger goes down I will be left stranded with some dead trucks.

- In the event a charger does go down, customers easily resort to offset breaks with the affected trucks temporarily doubling up on chargers to continue charging until the down charger is repaired.

14. Fast charging causes excessive gassing and won't meet OSHA or NEC standards.

- Some fast chargers struggle with excess gassing towards the end of charge due to a lack of comprehensive full range charge control. Therefore, many fast chargers limit charging to a maximum of 80% during "normal" work hours – hence the term "80% fast chargers". For these chargers, full charging and equalization is usually reserved when the facility is dark or on weekends.
- Minit-Charger does things differently. Through use of Minit-Charger's precision adaptive charge control method, equalization occurs anytime when and when time permits. Precision lab and field measurements under the lift truck hood shows compliance with both OSHA and NEC in regards to gas generation.

15. Fast charge batteries cost up to twice as much.

- Typically, ordering batteries for fast charging adds about 15% - 25% to the cost of the battery. Recent discussions with 4 battery people 7-10% including SPWS.
- This includes double intercell connectors, extra cabling and connectors, single point water system and the addition of the on board battery module. Premiums above this may included extended warranties.

16. When all the trucks come in to charge, I will trigger extra power costs from the utility.

- Potentially true for high kW single station dedicated and parallel multi-station fast charger. A phrase heard with these systems: "Watch all the trucks come in at lunch and connect – and then watch the lights dim as the meter starts to whirl!"
- In contrast, Minit-Charger was developed by an affiliate of one of the largest electric utility companies in the US resulting in a design that minimizes power consumption and demand spikes. Minit-Charger's approach using staggered breaks with multi-stations or multi-station full sequential mode significantly reduces power demand spikes.
- Example of kW savings: 18 truck fleet using 48V batteries operating 2 x 10 hr shifts and a battery discharge rate of 60 amps per working hr:

Mfr	**No of chargers**	**Req'd No of circuits**	**Connected Power Load, kW**
Minit-Charger	**Six – 3 station Model 448e staggered**	**6**	**186**
Major battery mfr supplying fast chargers	Nine - 2 station	9	396
Parallel fast charger	Nine – 2 station	9	297
High power conventional charger sold as fast charger	Eighteen – 1 station	18	360
High frequency fast charger	Eighteen – 1 station	18	396

Note: Minit-Charger sequential technologies used with staggering can reduce connected load by almost 40% over the nearest competitor while retaining high charger utilization rates.

17. Batteries get too hot during fast charging and this voids the warranty.

- Some fast chargers with inaccurate temperature compensated charge control do increase the battery temperature significantly. Unlike after-the-fact temperature compensated chargers that reduce charge rate as the battery rapidly rises in temperature, Minit-Charger's adaptive charge method "listens" to the battery internal workings and limits the charge rate to only that which the battery can absorb. This effectively controls temperature rise by not indiscriminately overcharging the battery with the extra energy turning into heat.

18. How do I know that someone will be able to service the fast charger when I need it?

- Every Minit-Charger site is covered by a local representative to perform service when required. Frequently, customers prefer to perform their own service and Minit-Charger can provide training at the time of installation. As a safety net, all customers and service representatives are provided with a 24 x 7 x 365 service hotline number that becomes and additional resource should an unusual issue occur. Finally, most Minit-Charge installations include an on-site spare kit to allow an easy one visit repair if necessary.

19. I hear that acid spills are a frequent problem in fast charging.

- Minit-Charge pioneered the "correct" application of single point watering (SPW) systems on batteries for fast charging. Working with most SPW suppliers, Minit-Charger developed precise application tables to ensure float heights and battery head space are coordinated. Additionally, each customer is presented with a battery watering schedule at the time of start-up to coincide with operations that allow full charging routines without acid leaks out of the battery. Unfortunately, not all fast charger suppliers go to this degree to ensure safe and environmentally clean operations for their customers.

20. I hear that fast charging complicates watering the batteries and the batteries use more water than conventional chargers.

- The amount of water used is dependent on many variables not the least of which is charge control. Temperature compensated fast chargers that overheat the battery can consume as much or more water than conventional chargers. In comparison, Minit-Charger's charge control ensures the battery does not receive more charge than it can handle. Several field tests have confirmed that Minit-Charger uses less water than conventional chargers and, in one instance, used almost 50% less for the same workloads. In every application to date, Minit-Charger sites require watering only once per week.

21. I hear that if the batteries get too hot the fast charger simply stops and cause the trucks to run out of charge.

- Many fast chargers do stop if preset temperature limits are exceeded to avoid a thermal runaway situation. And if the fast charger does not return to service because the battery continues to remain hot, it is likely that the truck simply does run out of charge. And in some cases, with chargers that use no on-board modules to report battery status to the charger, some fast chargers will just continue to overcharge with resultant serious permanent damage to the battery.
- Heat is generated in the battery by the flow of energy in and out of the battery. When discharge rates are high more heat will be generated than when discharge rates are low. Also when improper charge rates are applied to the battery in such a way that the battery cannot absorb the extra energy at the rate it is introduced to the battery, heat also is generated.
- Minit-Charger takes the following approach: a) Ensure the application effort is correctly performed taking into account seasonal or cyclical variations in the fleet workload. The idea objective being to apply Minit-Charger so that a timely balance exists between the energy consumed out of the battery by the truck is promptly replaced to avoid low states of charge that lead to temperature rise. b) Minit-Charger's advantage in precise charge control provides for minimum heating of the battery during charging in that only the energy the battery can actually absorb is presented by Minit-Charger. In this way, extremes of heat and service interruption are avoided.

22. Why hasn't fast charge caught on after 8 years of commercial use?

- Fast charge has caught on! In 1998, when Minit-Charger was the first to introduce a line of intelligent, high power chargers that were controlled by the battery there were only 15 trucks nationwide running on a fast charger. Today, fast charge trucks easily exceed 10,000 trucks in large and small fleets. The Industrial Truck Association annual member survey reports that the market share for fast charge currently sits at about 9%. The number of sites and trucks are rapidly growing and the future share is expected to be 33% by 2010.

23. I hear fast charge requires air-gapped (vented tray) batteries and lift truck battery tray fans to keep battery temperatures within warranty limits.

- Minit-Charger's charge control and applications experience ensures that batteries are kept within reasonable temperature ranges during operation. No Minit-Charge applications have required the extra expense of special order air-gapped batteries or the costly modification of lift trucks to install small fans to air cool the battery. In contrast, some competitors routinely suggest the use of one or both methods to

control heat because of flawed charge control or poor application methods or inexperience. Also A.H. capacity is decreased by one plate size

24. My operators will not stagger breaks.

- Some operators will resist change in the workplace. Operator's concerns can usually be easily handled. Experience has shown that when the benefits of staggered breaks for the operator includes less crowding in the break area, easier access to the chargers and trucks and the ability to continue to take breaks with their workplace friends usually eliminates concern. Because of the significant financial benefit to the fleet owner, several Minit-Charger users have introduced friendly Team A versus Team B and C competitions including token prizes to eliminate the initial concern over staggered breaks.

25. Fast chargers use more power than conventional chargers and will increase my electricity bill.

- This statement needs first to be clarified. Did the speaker's statement mean "power" or did it mean "energy"? The words "power" and "energy" are commonly confused so clarification is required on what they are and how they are related. So, Kilowatts (kW) are power and Kilowatt Hours (kWh) are energy.
- Some people incorrectly use the words "power" and "energy" interchangeably. You can think of "energy" as a "stuff" that you can buy, transport, or use, like a gallon of gasoline or a kilowatt hour of electricity. "Power" is simply the rate at which energy is delivered, like gallons of gasoline per minute or kilowatts.
- Fast chargers can require more power and can increase the power bill by triggering peak demand rates. That's why Minit-Charger offers a complete product line that is sensitive to a facility's power situation. Minit-Charger's multi-station technology routinely delivers a low power requirement from both a connected load and a peak demand load perspective than competitor fast chargers.

26. Fast chargers take up more space than vertical rack battery changers.

- This is a myth created by the battery change machine manufacturers. In examining a fast charge station consisting of fast charger and lift truck, it is easy to observe that about 70% of the floor space for this installation is used by lift truck. A typical fast charge station (excluding the truck foot print) is approximately 8 - 10 square feet. It is the aggregate total of all stations that should be compared to the corresponding battery change area including all of the related equipment. Basically, the lift truck has to be parked somewhere, regardless of how the battery is recharged – whether by fast charger or battery changing and therefore is not included in the calculation.

- Minit-Charger, whether single station or multi-station products, have one of the smallest footprints compared to any competitor. And multi-station models offer even more station layout flexibility to satisfy even the most stringent space or layout requirements.

27. I can't use fast chargers in my existing building because they take more power than by conventional chargers.

- Fast charge customers with existing facilities that have limited power frequently choose Minit-Charger due to the extra low power requirements resulting from Minit-Charger patented multi-station technologies. Minit-Charger routinely beats the competition by using the priority sequential charging in stagger mode which allows up to 40% less connected load over the competition.

28. Why do fast chargers cost so much more than conventional chargers?

- Fast chargers have 3 to 6 times the power ratings over conventional chargers and the increase in the power section size and internal wiring contributes significantly to the cost. In addition, and depending on the fast charger manufacturer, additional cost is included for the control technology inside the charger as well as the on-board battery module. Finally, in multi-station capable fast chargers, additional cost is included for each of the stations and the additional charge distribution technology and hardware.
- Minit-Charger's product line offers a complete range of chargers, each of them designed to provide the right features for the application from pole mounted, ultra low footprint, high performance single station units to technology laden multi-station units that allow even the most power and space restricted facilities to use fast charging. Finally, every Minit-Charger comes standard with Minit-Trak, the industry trend setting data and information system that allows detailed evaluation of the entire system performance of battery, truck and charger.

29. How will the fleet keep running if you only have a few short time periods to recharge?

- The key is to balance the energy returned from the fast charger (returned at high rates for short periods of times) with the energy used out of the battery at lower rates over longer periods of time. Minit-Charger uses evaluation and simulation techniques to ensure this balance is attained even in the most demanding seasonal work periods. In essence, the fleet is maintained throughout the work week in the battery "sweet spot" of 30% to 80% state of charge range. (Batteries are eventually returned to full charge and equalized as needed during non-work hours if not possible during regular work hours.)

- Minit-Charger charges at the maximum but safe battery charge rate as dictated by the battery through the on-board charge control module. This patented adaptive charge control technology routinely trumps less capable temperature compensated methods that “foldback” the charger output as battery temperature quickly rises. Many temperature compensated chargers rarely come close to their nameplate output during the work week after the batteries have achieved their normal operating temperatures. And when you only have a few minutes through out the work shift to connect and return charge to the battery, the last thing you want is a charger that produces less than advertised.

30. Frequent short charges will kill the battery.

- Numerous lab tests and evaluation studies by the Advanced Lead Acid Battery Consortium and other industry groups confirm that “PSOC” (“partial state of charge” charging operations) work well with a properly controlled charger and do no harm to the battery. Historically, old charger technology using simple IVI charge controls did not allow interrupted charge cycles. Use of these charges in a form of opportunity charging usually resulted in early battery failure. With the advent of more sophisticated, micro-processor based charge control technologies more chargers can be used in “opportunity” service. Nevertheless, the old adage continues to be held as fact when the world has moved on.
- Minit-Charger experience routinely sees battery life equal to or better than a similar conventional installation. This comes from the charge control approach pioneered and patented by Minit-Charger.

31. I hear lift trucks will be damaged from the heat from the batteries.

- Minit-Charger application methods ensure that lift truck operations proceed with battery temperatures within manufacturer’s acceptable ranges. Proper use of the system results in lift truck operations that produce no additional stress on the truck.
- Just as in conventional charged and changed batteries – if the trucks are run down below 20% state of charge, the battery will generate excessive heat and some small amount of this heat may be conducted to the truck. Therefore, heat from the battery is rarely the cause of any truck problems. On the other hand, low battery voltages can affect the truck when the battery state of charge is below the aforementioned 20%. However, as long as the truck low SOC cutout is properly set the truck will stop operating before damage is incurred.

32. There have been no conclusive studies that show fast charging works.

- On the contrary, several studies by the Electric Power Research Institute (EPRI) and the Advanced Lead Acid Battery Consortium

(ALABC) have proved conclusively that fast charge works when the charge rate is properly controlled.

- The proof is in the pudding: After 8 years of use, major Fortune 500 customers as well as smaller independent businesses continue to use Minit-Charger.

33. Fuel cells will shortly be on the market and make fast chargers obsolete.

- Fuel cells generally offer the same work process and customer value proposition as fast charging when compared to conventional battery changing. Fuel cells are in their early trials with only a year or two of experience running a few trucks at a time. Ultimately, once development is completed and solutions for long term cell stack durability and low cost on-site hydrogen production and or storage are realized, cost bases will be a deciding factor if the performance requirements are met.
- Meanwhile, Minit-Charger continues to provide more value to our customers. Also, battery manufacturers increasingly see fast charge as a mainstream product for their customers and are more interested in adapting to the rigors of fast charge. Improvements in the overall fast charge system of fast charger and battery will continue that will result in ever increasing performance levels that fuel cells will have to meet to be competitive.

34. I only have budget for a partial (battery or forklift) fleet replacement this year.

- No problem. Minit-Charger can convert part of a fleet that is going through battery replacement or truck lease rotation without affecting the other trucks in the fleet. Many Minit-Charger customers start with a partial fleet conversion and progress on a timetable dictated by their own unique circumstances and economics.

35. We run our trucks all the time and don't have enough break time to recharge.

- As mentioned before, evaluation and application will reveal the actual conditions under which the fleet operates. Many times even the busiest fleet will have scheduled downtimes where the operator performs paperwork or other job-related duties while the truck is connected and being charged. Once the data has been collected, simulations can be prepared to visualize the future operation with Minit-Charger.

36. I'm told that "dedicated" chargers are better (one charger for each truck).

- This myth is perpetrated by fast charger suppliers that have not invested in developing multi-station chargers that address customer's

needs to keep connected load low and minimize power demand spikes. (The term “dedicated” is interchangeable with single station chargers.) Minit-Charger’s multi-station technologies combine patented sequential charging with staggered breaks to achieve extra low electrical loads on the facility.

- Typically, single station units are used in very small fleets such as 2 to 5 trucks where the combined power requirement is not overwhelming. A frequent other application is in large manufacturing environments where extensive amounts of available power and circuits are integral to the facility. These facilities also tend to offset the high peak loads delivered by the chargers when all trucks come in at the same time to charge by shutting down the power hungry assembly line. If these conditions exist then a customer should consider Minit-Charger single station chargers.
- Generally, an evaluation and a simulation of a customers operation can point to the best overall solution that meets the objective of high state of charge for the trucks, low installation cost, power requirements consistent with what’s available in the facility and ease of use by operators. To accomplish this, a customer should work with Minit-Charger to access a full array of single and multi-station product to allow the best choice to be made.

37. Multi-station chargers are too complicated.

- Operators see no difference in use of a multi-station charger over single station chargers. In either case the operator drives up and connects to the charger or the charge station. The charger does the rest. Multi-station chargers are more sophisticated in features in order to deliver important advantages to customers over single stations units. Frequently, Minit-Charger’s multi-station chargers overcome the lack of power availability in the facility or high circuit and panel installation costs that otherwise would have prevented a customer from converting to fast charging.
- The maximum benefit from multi-station technology is yielded when the charger system utilizes sequential charging. Only in this way can the charger present the lowest power demand on the facility and, when used in conjunction with staggered breaks, deliver the maximum charge return with every truck receiving charge every time the truck is connected. Only Minit-Charger offers patented sequential charging technology for lift truck fast charge use.

38. I hear some early users of fast chargers have returned to battery changing.

- Every Minit-Charger customer over the last 8 years has continued with fast charging.

39. Using battery modules increases fast charger failure rates.

- On the contrary, NOT using battery modules to interface the battery with the charger leads to problems from inadequate charge control and potential excessive and damaging battery heat. When using high charge rates, the actual real time battery condition must be used to control charger output. In the absence of this important battery – charger communication, the fast charger may not provide a consistent workable high charge rate or, in the worst of cases, may cause unsafe overcharge conditions.
- Minit-Charger BICC and BDC technology was developed to ensure direct interactive link between the battery and the fast charger. In this way the conditions of the battery determine the correct charger output leading to the highest safe charge rates.

40. All battery modules perform the same functions.

- A variety of battery modules are offered from fast charger manufacturers for use with their respective fast charger. There are no cross compatible battery modules. These battery modules vary significantly as to function, capability and importance in charge control. Some battery modules only log battery identification and the date the battery was placed in service. Others include temperature and voltage sensors. Others employ limited data logging and storage. Others yet include charge control function. Therefore, there are wide differences battery module function, capability, performance and component cost.
- Minit-Charger's BICC and BDC battery modules incorporate Minit-Charger's patented charge control methods. As their primary function, both the BDC and the BICC communicate a variety of battery parameters, in real time, to their respective fast charger to determine and control charge output, including destratification, "full" charge rates and equalization charge. In their secondary function, both BDC and BICC store 500 and 2000 charge cycles, respectively, of 20 data points of battery and charger data such as battery state of charge, battery temperature, equalization frequency, connect frequency, etc. Graphical display of data by use of Minit-Charger's trend setting Minit-Trak proprietary system information software allows easy evaluation of system performance. Minit-Trak comes standard on every Minit-Charger.
- Many fast chargers store data charge cycle data in the charger. This makes data collection for a single problem truck difficult because data must be downloaded from every charger to allow sifting for the specific truck. Minit-Charger technology allows all the historic data for truck to be downloaded directly from the truck in one single action. Only a laptop and a Minit-Trak software is required to gain data that allows informed decision making.

41. Charger data and information systems are unimportant and costly.

- Minit-Charger includes Minit-Trak system information with every Minit-Charger as a standard feature. Many fast charge manufacturers list their data logger versions as “optional”, if they provide one at all.
- Data of any kind is unimportant until you need it to make an informed decision. Most Minit-Charger customers have used Minit-Trak data to assist them in planning operations changes to their fleets, reschedule shift duties and hours, expand or contract fleets due to varied seasonal duty changes and to determine team productivity. In some instances, customers have combined Minit-Trak data with other data such as “SKU’s shipped” to provide a comprehensive analysis of their operation in order to seek areas of improvement or for planning for new facilities.

42. Fast chargers are only good applications for new facilities.

- Minit-Charger has an approximately even split of applications in new and existing facilities. Several major customers with existing facilities continue to expand throughout their organization based on the excellent economics of Minit-Charger. Minit-Charger technologies combine to ensure a high degree of “fit” with existing building power availability in contrast to competitor fast chargers.

43. Fast charging is too new to trust.

- Eight years and thousands of trucks have proven that fast charging delivers on its promises. Long term evidence exists that battery life is equal or better than conventional battery charging and changing. Minit-Charger has accumulated over 20 million charger shift-hours of successful use by customers who have found reduced costs in charging their lift truck batteries.

44. Fast charging is a niche application for only certain sites and fleets.

- “Show me the money.” Economics determine the fit of fast chargers to a facility. Generally, the higher the level of energy throughput in the lift truck fleet the greater the savings. There are no specific niches or size of fleets to which fast charging is limited.
- In the absence of high throughputs, the customer can also consider converting to lower power “opportunity” charging where conventional chargers are replaced with chargers designed to maintain good battery life while performing partial charges. Minit-Charge provides a full line of products for all of these applications.

45. Fast charging can’t do 3 shift operations.

- There are many 3 shift operations successfully using Minit-Charger. Bottom line is if there is sufficient charge time in relation to the amount of amp-hrs consumed and sufficient time to full charge every few days and equalize once per week then the number of shifts per day

becomes irrelevant. Frequently, 2nd and 3rd shifts are less than full fleet operations leaving added time to complete necessary charging. A quick analysis and evaluation can usually confirm viability of Minit-Charger for a 3 shift fleet.

46. I'll get caught between the battery vendor and the fast charge manufacturer if there are problems.

- All major battery manufacturers are familiar with Minit-Charger through successful long term use of their battery with Minit-Charger. Further, an active and open dialog exists between battery manufacturers and Minit-Charger technical staff ensuring easy resolution if any issues arise.
- Minit-Trak™, the proprietary data and information software that describes battery, charger and truck performance in detail is available for use by all battery manufacturers as well as the customer to allow joint review of system performance. Minit-Trak has shown to be an effective tool to provide impartial insight and assist quick resolution of any performance issues. Minit-Trak is provided with every charger Minit-Charger sells.

47. Opportunity charging is less expensive and will do the same as fast charging.

- For clarification, opportunity charging defines using a charger to charge a lift truck battery at every convenient opportunity. The intention is that frequent partial charges will keep the battery at a sufficient state of charge to allow the lift truck to keep running through out the work day. It is estimated that, contrary to battery manufacturers recommendations, about 30% of all trucks are opportunity charged with conventional chargers at the risk of lower than average battery life.
- "Fast charging" is opportunity charging with the use of high output rate chargers that significantly exceed a conventional chargers output rate of 150 to 200 amps. "Fast chargers" are generally considered to have an output of 300+ amps. A new offering of "opportunity" chargers from a variety of conventional and fast charge manufacturers operate in the 100 to 250+ amps output rate to accommodate customer's desires to increase battery life while opportunity charging and to eliminate the last of any battery changing in their facility.
- Is opportunity charging less expensive than fast charging? The answer is yes – but only if the fleet energy throughput need is accommodated by the lower output of an opportunity charger.

48. I hear I will need extra trucks to make fast charging work in my facility.

- In the great majority of cases, no increase in truck count is necessary when converting to fast charging. In some cases, truck

count eventually decreased because of the productivity gains delivered by Minit-Charger (fewer trucks required to do the same amount of work).

- In rare cases (less than 2% of all sites), the customer's extreme heavy duty cycles warranted a minor increase in trucks to allow staged trucks to be rotated in and out of the fleet to increase the fleet average state of charge. In each of these cases, the added trucks were bought and paid for by the operational savings while still allowing an attractive payback proposition. These applications are unusual in the intensity of daily fleet energy use and the brevity of break and other times available for fast charging.

49. Is Minit-Charger a pulse charger?

- No. Minit-Charger does not use "pulse" charging as its control methodology. It should be known that a variety of investigations in to the merits of pulse charging reveal little to no benefit in this methodology used by some competitor fast chargers.

50. How much modification is required to the lift trucks?

- Many lift trucks come fast charge ready from the factory when so ordered. These trucks normally only require field completion of final battery cable and battery module communications cable connections. Existing lift trucks can be converted by a lift truck or battery shop to install the aforementioned cables.