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General guidelines on handling Traction cells

Pay attention n to the operating manual and fix them close to the battery. Work on batteries has to be carried out by skilled personnel only

Face shields, safety goggles and protective clothing must be worn when working on batteries

No smoking! Do not expose batteries to naked flames, glowing embers or sparks, as it may cause the battery to explode

Risk of explosion and fire, avoid short circuits! Do not place tools or other metal objects on the battery

Electrolyte is highly corrosive

Batteries and cells are heavy. Ensure secure installation!

Dangerous electrical voltage

1. Commissioning of filled and charged batteries:

1.1. Putting into service:

The battery should be inspected visually to ensure it is in perfect condition. The charger cables must be connected to confirm a good contact, with careful attention to the polarities. Otherwise battery, vehicle or charger could be damaged. Prior to charging, firm attention must be paid to the following points:

- The level of the electrolyte must be checked after removing the plugs. The electrolyte level of each cell should be between the high and low levels (can be visualized in basket) & must be about the same in each cell.
- Differences in electrolyte level can be adjusted by removing electrolyte from high- level cells and adding it to low-level cells. In case where Autofill system is installed, the plugs should be removed carefully avoiding any damage to the float body & the piping system.
- The tightening torque for all the connector bolts must be 25±2 N·m.
- All the intercell connectors must be thoroughly checked for adequate tightness even after tightening of the bolts.
- The battery is then charged as prescribed in point 2.2. After charging, the electrolyte should be topped up to the nominal level with DM water.

1.2. Fitting on the vehicle:

- Top of the battery should be wiped clean & dry. All bolted connections to battery terminals should be smeared with appropriate Anti Corrosive Renolit G-PF1 and then tightened up.
- Connecting cables should be well anchored and sufficiently long to prevent pulling on battery terminals. The cells must be accessible to facilitate testing and topping- up.

2. Operation:

2.1. Discharging:

It must be ensured that all ventilation openings of the battery container, compartment or cover are not blocked, so suitable ventilation of the battery is achieved. Electrical connections must only be made or broken in the open circuit condition *(not during charging or discharging)*. To achieve the optimum life for the battery, operating discharges must be limited to not more than 80 % of the rated capacity. This corresponds to an electrolyte specific gravity of not below 1.130 gm/cc at the end of the discharge Discharges beyond 80% are categorized as deep discharges and are not allowed as they will considerably reduce the life expectancy of the battery. Discharged batteries must be recharged immediately and not be left in a discharged condition. This is applicable to partially discharged batteries also.

2.2. Charging:

Charging should be carried out with DC current only. The battery should be connected to a preassigned charger appropriate for the size of the battery, in order to avoid overloading of the electric cables and contacts and prevent undesirable gassing. The battery should be connected to charger switched off ensuring the correct polarity following which the charger is switched on. If removable tray cover is provided, it should be removed prior to charging to provide proper ventilation in order to prevent accumulation of explosive gas mixtures. During charging, electrolyte temperature rises due to internal exothermic electrochemical reactions. Thus, charging should only commence if the electrolyte temperature is below 45 °C. Alternatively,

the electrolyte temperature of batteries should be at least +10 °C before charging otherwise a full charge will not be achieved.

The batteries should be charged as per the following charging regime in order to extract the optimal performance from the batteries as well as extending the longevity of the batteries. It is vital that the output of the charger is matched to the capacity of the battery.

Typical IUI charging regime:

Step 1 - @15% of Rated C5 till 2.4 vpc

Step 2 - Constant Volt @2.4 vpc till the Current tapers to 7-8% of C5

Step 3 - @7-8% of C5 till

- The Specific Gravity rise becomes constant
- Cell voltages reach 2.65Vpc or charge cut off as per dV/dt setting

2.3. Equalization charge:

Traction cells over a period of use develop unequal state of charge (unequal specific gravities with a difference of more than ±0.020 g/L) and needs to be equalized from time to time. If this state of inequality is allowed to persist, the battery loses its effective capacity.

Equalizing charges are carried out following normal charging.

Connect the battery to a charger and commence charging at 3% of battery capacity in Amperes. The current has to be kept constant throughout the charging process. Top Up all cells up to requisite level with DM water. Take hourly readings of specific gravity, voltage and temperature.

Equalization charges are to be mandatorily carried out weekly for 10-12 hrs.

2.4. Temperature:

An electrolyte temperature of 30°C is specified as the rated temperature. Higher temperatures shorten the life of the battery, lower temperatures reduce the capacity available which falls considerably under 0°C. Optimal battery life is obtained with a battery temperature of 15-35°C

55°C is the upper temperature limit and any temperature beyond this temperature is not acceptable.

2.5. Electrolyte:

The rated electrolyte density is related to a temperature of 30°C and the nominal electrolyte level in the cell in fully charged condition. Higher temperatures reduce the electrolyte density & vice-versa. The temperature correction factor is -0.0007 g/ml per °C.

Operating electrolyte specific gravity of a fully charged cell should be 1.275 -1.285 gm/cc at 30°C.

3. Maintenance:

3.1. Daily:

Recharge the battery fully after every discharge. Allow the battery to cool down to 30°C before using. Check the condition of the vent plugs, cables and that all insulation covers are in place and in good condition. Towards the end of charge the electrolyte level should be checked and if necessary topped up to the specified level with DM water. In case of push-fit plugs, this is indicated by the minimum level marked by the plug basket. When an autofill plug is used, this is specified by the level indicator. Battery should never be topped up with acid.

3.2. Weekly:

Visually inspect for signs of dirt and mechanical damage to all components of the battery, paying particular attention to the battery charging plugs and cables. Ensure that the battery receives an equalization charge each week & also check for acid Level twice a week for water loss and arrange for necessary top up with DM Water as and when required. Record specific gravity of all cells after equalization charge each week.

3.3. Monthly:

At the end of the charge, the voltages of all cells should be measured and recorded, with the charger switched on. After charging is completed, the electrolyte density and temperature in all cells should be measured and recorded. If significant changes from earlier measurements or differences between the cells are found, further testing and maintenance by our Service Dept. should be requested.

If adequate backup is not being provided by the battery:

- Check that the required work load and pattern is compatible with the battery capacity.
- The capacity and settings of the charger are correct and sufficient charge time is being
- The vehicle discharge limiter settings are correct

Thorough cleaning of batteries must be done monthly. Batteries having drainage holes should be cleaned with water. For batteries without drainage hole, the spilled acid must be siphoned out of the tray and the battery must be cleaned with a wet cloth.

For batteries having autofill system, the entire system must be cleaned by flowing lukewarm water quarterly once.

3.4. Annual:

Test all electrical connections of battery and charger (sockets, cables, and contacts). Check the torque loading of all the bolts and screws on the batteries. Check the insulation resistance of the truck and battery in accordance with DIN EN 1175-1, DIN EN 1987 part 1. In accordance with IEC 62485-3, a battery in use, having a nominal voltage not higher than 120 V d.c., shall have an insulation resistance of at least 50 Ω multiplied by the nominal battery voltage but not less than 1 kΩ when measured between a battery terminal and metallic tray, vehicle frame or other conductive supporting structure. If the nominal battery voltage exceeds 120 V d.c. an insulation resistance of at least 500 Ω multiplied by the nominal battery voltage is required.

In case of batteries fitted with Air agitation system, the entire piping system must be cleaned thoroughly with water. The pump must be checked for correct operation & the air filter is to be cleaned also.

4. Care of the battery:

A clean battery is an absolute necessity, not only because of the superficial appearance but rather in order to avoid unprecedented accidents and damage as well as extending its service life. The battery should always be kept clean, tidy and dry to prevent any buildup of leakage currents. Any liquid deposition in the battery tray must be cleaned and disposed of as early as possible. Damage to the insulation of the tray should be repaired after cleaning, to ensure that the insulation value complies with the value as prescribed in 3.4 and to prevent tray corrosion.

4.1. Battery cleaning procedure:

- Prior to cleaning, remove the battery from the vehicle.
- The place for cleaning must be chosen in such a way that the rinsing water containing electrolyte will flow into a facility suitable for the treatment of waste water. When disposing of used electrolyte and/or rinsing water, observe the regulations on health and safety at work and on accident prevention, as well as the regulations concerning water and waste disposal.
- The cell plugs must not be removed or opened. They must keep the cells closed.
- Plastic parts of the battery, in particular the cell containers, must only be cleaned with water and/or wet cleaning cloths without any cleaning agents.
- After cleaning, dry the battery surface with appropriate means, e. g. with compressed air or with damp antistatic cleaning cloths (e. g. cotton).
- Any liquid that is spilled into the battery tray must be removed by suction and disposed of in accordance with the safety & environmental regulations.
- Vehicle traction batteries may also be cleaned with high pressure cleaning equipment. Also observe the operating instructions for the high-pressure cleaning appliance.

In order to avoid damage, during cleaning, to the plastic parts, such as lids, the insulation of the intercell connectors, and the plugs, observe the following points:

- The intercell-connectors must be securely screwed down or pushed in tightly.
- In case of bolted terminals, the bolt must be tightened with a torque of 25±2Nm.
- The plugs must be in place and closed.
- Cleaning agents must not be used.
- Clean large surface areas of the battery at a time, in order to avoid localized overheating.
- Do not use air heaters with an open flame or with glow wires.
- The surface temperature of the battery must not exceed 60 °C.

5. Storage:

Batteries are dispatched from the manufacturer in a fully charged condition. The state of charge will decrease with storage when allowed to stand due to chemical reaction. If batteries are taken out of service for extended periods of time, they should be stored in a fully charged condition in a cool & dry room (recommended temperature <35°C). For all cells that have crossed 3 months from the date of initial charging need to be provided freshening charge through existing compatible charger available at site. Any cell can

only be charged thrice (once every 3 months) in this manner. Thus, no cell can be stored more than 9 months following its initial charging.

Regular inspections should be conducted & if the OCV is found to be below 2.10 volt per cell, then a freshening charge is recommended.

The storage time must be considered when calculating the life of the battery.

Never store a battery in a discharged state.

6. Troubleshooting:

Exide HSP Motive Power & GenX batteries are assembled with the greatest care using thoroughly inspected components. Faulty operation however will seriously curtail long life built into each battery.

It is most important to act at the earliest. When necessary, seek the aid of the nearest Exide Office.

The following table will help you identify improper battery conditions, their probable causes and recommended corrective actions. Contact Exide Industries Service personnel for further assistance.

Condition	Probable causes	Corrective Actions
Excessive watering required	a) Overcharging	a) Use a properly sized charger b) Optimize the charging time
Unequal or low specific gravities	a) Loss of electrolyte due to overwatering or watering before charge is completed b) Incomplete charge c) Stratified electrolyte d) Charger malfunction	a) Provide an equalization charge as prescribed
Low cell voltages	a) Low specific gravity b) Short circuit c) Voltage leak between cells or tray	a) Provide an equalization charge as prescribed b) Clear short or replace cell c) Clean battery top
Excessive cell temperatures	a) Weak or defective cell b) Charger too large for the battery c) Low electrolyte level d) Short circuit e) Insufficient air circulation around battery on charge f) Inadequate cooling time g) Over discharge	a) Repair or replace cell b) Use properly sized charger c) Water cell after battery is fully charged d) Clear short or replace cell e) Reduce charging room temperature and increase ventilation f) Allow at least 1 hr. cooling after charge g) Limit discharge to 80% of rating

7. Tools & Spares:

The following instruments and materials will be useful in maintaining battery in service.

a. One Hydrometer, type V2B
b. Gravity Correction Thermometer
c. Digital Multimeter

d. Battery Grade Water
e. Battery Grade Sulphuric acid of 1.400 SG

Ammonia and acid-resisting paint will be useful for protecting the trays etc. against the effects of acid spillage.

Burning Equipment:

For carrying out battery burning for repairing it is essential to have some means for lead burning. The most common requirements are:

a. Oxygen & Acetylene Flame
b. 2 nos. Suitable connector burning rings
c. 2 nos. Suitable take off burning rings
d. 2 nos. post build up rings
e. Drill machine
f. Hollow post cutter drill bit
g. 2 nos. Cell lifting puller

Spares:

a. Flip-top vent plug with basket type level indicator
b. Intercell connectors
c. Connector & take-off shrouds

8. Selecting the right battery:

Each Traction cell is of 2V and therefore the nominal voltage of a Motive Power battery would be the number of cells multiplied by 2. The nominal capacity of the battery is the Ampere Hour (Ah) capacity at 5 hour rate of discharge @ 30^{o}C at 1.280 (27^{o}C) specific gravity to an end voltage of 1.70 Volts per cell. It is designated by a symbol C5. For example, a battery with a C5 of 500 Ah will deliver 100 Amperes for 5 hours.

The choice of battery is determined by:

a. The Voltage system of the battery (e.g. 12V, 24V, 36V, 48V, 72V etc.)
b. Load pattern or duty cycle of the battery
c. The space available for the battery
d. The capacity of the Truck
e. Availability of suitable charger in line with the capacity of the battery

It is highly recommended to maintain multiple batteries per truck such as 2.5 to 3 batteries per truck where the operation is round the clock and for 365 days a year & 1.5 to 2 batteries per truck for a 2 shift operation per day 365 days a year. This allows the batteries to cool down after charging & increase the operating life of the batteries.

For replacement batteries, the selected battery size must be equal to or higher than the battery size specified by the OEM. In case of heavy application, it is recommended to select a higher battery size.

Battery life depends on temperature of topping up water, depth of discharge, proper charging, regular maintenance, ambient conditions etc. The cycle life is declared by manufacturer as per Reference Testing standard of IEC 60254-1-1997.

9. Automated Water Filling system:

9.1. Advantages:

Automated water filling system ensures topping up of batteries in an efficient & trouble-free manner, thereby eliminating any possibility of human error.

9.2. Operation:

Each cell is equipped with an automatic water filling plug that consists of a valve and a float and controls the topping up process to maintain the optimal electrolyte level. A valve is displaced by the float inside the plug. This valve controls the amount of water required for topping up. The water pressure blocks any further water flow and safeguards the cells from overflowing. The battery should be topped up ½ hr before the end of charging to achieve a good mixing with the electrolyte and the correct level.

9.3. Filling time:

The filling time depends on the usage and operating temperature of battery. After end of filling, the water supply connection must be closed to avoid unnecessary wastage of water.

A flow indicator built into the supply tubing monitors the filling process. During filling the water flow causes the built-in disc in the flow indicator to turn. When all the plugs are closed the disc stops, indicating that the filling process is complete.

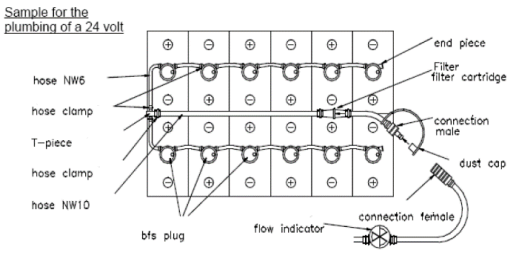
9.4. Water pressure:

In case of water filling by gravity, the distance between the bottom of the tank to the top of the battery should not be more than 2 meters.

9.5. Operating temperature:

Auto fill system must not be used in places where temperature goes below 0°C in order to avoid freezing of water & clogging of the piping network.

9.6. Autofill system layout:



BFS Plug:

Filter Cartridge:

Connection Male:

Flow Indicator:

Connection Female:

Dust Cap:

Water tank:

Plastic hose (6 mm/ 10 mm):

9.7. Autofill Fitting procedure:

a) Fix the FLOAT in the BFS-PLUG III (PUSH IN)
b) Open the vent caps & push the above attachment
c) PVC NW6 Hose pipe to be cut as per required length between 2 nos. BFS - PLUG III as per drawing
d) Hose clamp NW6 mm to be inserted at the two ends of cut PVC NW6 Hose pipe
e) Connect the cut PVC NW6 Hose pipe between 2 plugs as per layout drawing & push & lock the pipe with the help of Hose clamp NW6 mm
f) Fix the end piece to the last plug which is devoid of any connection with cut PVC NW6 Hose pipe
g) Connect the Tee for auto fill required for branching between 2 plugs with cut PVC NW6 Hose pipe shown as per layout drawing & connect the PVC Hose NW10 to the 3rd mouth of the Tee
h) Cut the PVC Hose NW10 approximately 300 mm more than that of the tray length
i) At the other end of the PVC Hose NW10 fix the dust filter with the Hose clamp NW10 mm – dust filter arrow should face towards the Tee
j) Cut 100 mm from left over PVC Hose NW10 & connect one end of the hose to the other end of the dust filter
k) On the other end of the 100 mm hose connect the flow indicator – the arrow should be pointed towards the Tee
l) Cut another 100 mm of PVC Hose NW10 & connect it to the other end of the flow indicator
m) Insert the dust cap to the Connection male NW10 & connect it to the free end of 100 mm of PVC Hose NW10 of Serial No: 12
n) Lock the Connection Female NW10 to the Connection male NW10

Note: For each & every connection, use of Hose clamp NW6 mm is mandatory

10. Air Agitation system:

10.1. Advantages:

Air agitation system prevents stratification of electrolyte and reduces charging time, reduces electrolyte temperature during charging. This in turn reduces water loss, electricity consumption & enhances the operating life of the battery.

10.2. Operation:

Air agitation system consists of pipes & other tubing pieces fitted in each cell. An air pump which may be in-built inside the charger or placed externally, produces air flow which is guided into each cell through the piping network. The air pump is to be selected based on the number of cells & dimension of cells (Bigger cells require more air flow as they contain greater amount of acid).

10.3. Air Agitation Components:

Adapter:

Connection Male:

Connection Female:

90° piece:

T piece connecting to air pump

Tube:

T piece:

L piece:

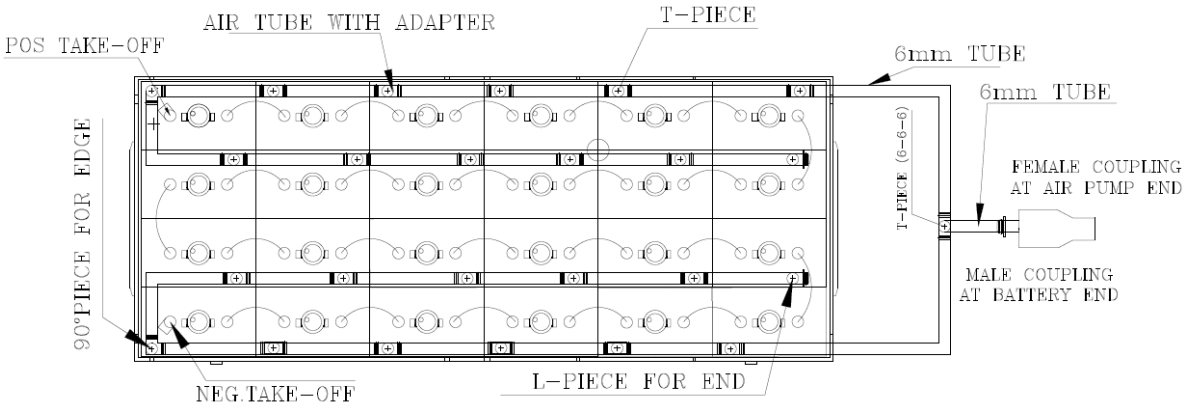
Plastic hose (6 mm/ 10 mm):

10.4. Air Agitation fitting procedure:

a) Fix the adapters on top of each of the pipes
b) Cut the PVC pipes as per required length as mentioned in the layout drawing
c) Fix the two end pieces at the terminals as mentioned in the layout drawing
d) Arrange the 90°-pieces & T-pieces as per prescribed in the layout drawing
e) Connect all the PVC pipes with the individual components & check for proper tightness
f) Fix the T-piece connecting to the air pump in the appropriate place as mentioned in the layout drawing
g) Lock the Female & Male connections & check for tightness
h) Connect the system to the air pump & switch on the pump

i) Check if the air circulation is working or not

10.5. Air Agitation system layout:



11. Electrolyte Level Indicator:

Electrolyte level indicator is a very simple tool that can drastically improve battery maintenance by alerting personnel when the battery requires topping up. Without any indication, it can be very difficult for the operator to know whether the battery needs topping up or not. Electrolyte level indicator prevents the battery from drying out which if unnoticed may lead to premature failure.

Two types of electrolyte level indicators are available:

Basic Blinky

Smart Blinky

11.1. Classic Blinky Fitting procedure:

- Select 3 cells in series, towards the center of the battery
- The probe to be installed in to the most positive cell of the 3 cells (cell closest to main positive terminal of battery)
- Drill hole in the lid of the cell by using appropriate drill bit.
- Ensure that the area under the hole is clear to the cell separator
- Trim the probe using wire cutters so that the tip be 3 mm above separator when fully inserted in to the cell
- Fix the rubber grommet in between the probe & drilled hole
- Count 2 cells towards main negative terminal of the battery & connect black wire to the negative terminal of that cell

Bolt – on Battery:

- The Blinky connectors to be installed between the head of the bolt & the intercell connector
- Apply renolite between bolt & Blinky connector

Weld – on Battery

- To fit the Blinky connectors to Weld – on battery, drill a hole with the 3 mm drill bit in to the correct solid lead cast connector
- Fasten the ring at the end of the wire to the connector using the screws provided

11.2. Smart Blinky Fitting procedure:

- Select 3 cells in series, towards the centre of the battery
- The probe to be installed in to the most positive cell of the 3 cells (cell closest to main positive terminal of battery)
- Drill hole in the lid of the cell by using appropriate drill bit
- Ensure that the area under the hole is clear to the cell separator
- Trim the probe using wire cutters so that the tip be 3 mm above separator when fully inserted in to the cell
- Fix the rubber grommet in between the probe & drilled hole
- Connect white wire to negative terminal of the cell with the probe.
- Count 2 cells towards main negative terminal of the battery & connect black wire to the negative terminal of that cell

Bolt – on Battery

- The Blinky connectors to be installed between the head of the bolt & the intercell connector
- Apply renolite between bolt & Blinky connector

Weld – on Battery

- To fit the Blinky connectors to Weld – on battery, drill a hole with the 3 mm drill bit in to the correct solid lead cast connector
- Fasten the ring at the end of the wire to the connector using the screws provided

Tools & Instruments Required:

1) Smart/Classic Blinky battery watering monitor
2) PVC grommet
3) Drill
4) 12 mm drill bit
5) 3 mm drill bit
6) Screw Driver
7) Wire Cutters
8) Hammer & Punch
9) Torque Wrench with 22 mm socket

Note: If connections are O.K then Green light will blink continuously