UKMHA
UK MATERIAL HANDLING ASSOCIATION

Guidance Notes

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IMPORTANT NOTICE – PLEASE READ CAREFULLY

Lead Acid Traction Battery Applications

(a) The recommendations and advice contained in this Guidance Note are based on specifications, procedures and other information which have been collected by the UK Material Handling Association Limited (UKMHA) from its members. They represent what is, so far as UKMHA is aware, the best available data at the time of publication on the construction and use of industrial trucks in the general conditions described, and are intended to provide guidance for such use.

(b) However, there are a wide variety of situations in which industrial trucks may be used, consequently in all cases the suitability and safety of this Guidance Note must be determined by the person seeking to apply it on the basis of his own judgement, in the light of the conditions in which use is envisaged and subject to all relevant statutory requirements.

(c) UKMHA accepts no responsibility for the recommendations, advice, statements, opinions and conclusions expressly or by implication set out below and gives no warranty or representation of assurance in respect of the accuracy or validity of the same.

This Guidance Note (GN) is Generic in content and does not refer to any individual battery or MHE manufacturer. The advice where provided is from the MHE industry and is endorsed by the UKMHA TPC members.

Source of information:

UKMHA associated suppliers and manufacturers of Traction Batteries, Chargers, and MHE products. The BSI CENELEC, IEC and ISO standards, available from the websites of those organisations.

1 SCOPE

The Guidance Note covers Traction Battery Applications;

- Safety
- Operating
- Charging
- Changing
- Maintenance / repair
- Topping-up (Watering)
- Ventilation of batteries and battery charging locations
- Safe distance from a battery under charge
- Vented Batteries with liquid electrolyte
- VRLA (Valve Regulated Lead Acid) Batteries with Gel and other forms of electrolyte
- ATEX batteries
- Disposal of Batteries at end of life

1.1 It Does Not Cover

Automotive battery applications (also known as Transportation batteries).
Stationary battery applications (also known as Network Power or Standby batteries).
Electric Road Vehicle applications (electric cars, buses or commercial vehicles).
Batteries which are not Lead acid combinations of plates and electrolyte.

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2 DEFINITIONS & APPLICATIONS

2.1 Refer to **BS EN 62485-3:2014 Safety requirements for secondary batteries and battery installations – part 3 – Traction batteries**, for Traction Application definitions.

Some definitions do cross over from Automotive and Stationary applications and standards, and the following descriptions may prove useful when using this GN, if the product you have is used in such a manner.

2.2 Traction Application

Where a battery is used as a source of power to create movement of a piece of equipment or vehicle. The batteries are used in a cyclic manner by being alternately charged and discharged in a normal working day/shift system.

2.3 Traction Battery Charging

The charging methods for Traction batteries generally provide a defined profile to recover the battery from 80% depth of discharge in a set period of time, often referred to as 6, 8 or 12 hours, to suit the day/shift patterns required of them.

2.4 Traction Battery Changing

Some applications require spare batteries charged separately to the MHE truck, which results in the discharged battery requiring extraction from the truck, and exchanging taking place with another charged battery.

2.5 Traction Battery Topping Up (also known as watering)

After a period of charge and discharge to 80% depth of discharge, the electrolyte loses some water during the gassing phase of the charge. The electrolyte level is tidal, and its height depends upon its state of charge. When fully charged it is at the current highest tidal level, and it is at this point where the decision to top-up is taken. Only top-up a traction battery when it has completed a full charge to termination. This is to avoid over-topping and loss of electrolyte as the tide rises during charging. Your OEM can advise the correct level after topping for any products they provide.

2.6 Opportunity Charging

This is a method of providing supplementary charges during a working day/shift to extend the working period of the battery, by charging it when periods of idle time are available.

This is not free power and every period of opportunity charge chips away at the cycle life expectation, and will reduce overall cycle life. Frequent Opportunity Charging can elevate battery temperatures and this also can have an impact on battery life.

2.6.1 Partial State of Charge (Opportunity Charging)

Partial State of Charge is an application which is very specific and if considering it seek advice from your OEM. The OEM would advise on suitable electrical distribution required for the charging regime, and how to manage equalize and thermal operational conditions, which may be part of the operational requirements of the Partial State of Charge application.

2.7 VNA AC Bus-Bar Supply Charging the Battery

This concept takes VNA (Very Narrow Aisle) MHE and via a collector system feeds Three-Phase AC to the truck's on-board battery charger, which is connected across the battery and the VNA truck. The charger contributes to the power demanded by the VNA, and when possible charges the battery.

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2.8 AGV (Automated Guided Vehicle)

The truck has no human driver and follows a set route which guides it from point to point. There are generally battery chargers at certain points where the vehicle can stay stationary long enough to obtain some charge, before disconnecting and moving to the next charge point.

There are many applications and most fall into those described and the next part covers the basic safety measures for those using traction batteries.

2.9 O.E.M (Original Equipment Manufacturer)

This Guidance Note refers an end user in some sections to their OEM supplier for further advice, information or assistance. The OEM will be the Manufacturer of the Materials Handling Equipment / truck, which would then link you to their resources.

3 SAFETY

The degree of personal protection depends upon the level of contact an individual has with the battery. A risk assessment should be carried out to determine what level of precautions are taken, and the training required.

In all levels of contact with an MHE industrial truck/AGV that's powered by a battery, the elimination of electric static discharge is a basic safety requirement, not only of the operator but of items which may be placed on the truck by the operator, which may generate static. The amount of energy to ignite hydrogen gas is very small, and if such sources are eliminated, the safer the environment becomes.

4 OPERATING

4.1 Driving/Operating the MHE Truck

If the driver/operator of the MHE truck is not required to expose the battery compartment, and will never touch or view the battery, then the PPE (Personal Protective Equipment) level will reflect this.

5 CHARGING

5.1 Driving/Operating the MHE Truck and Charging the Battery

This raises the level of contact with the battery and therefore additional PPE may be required, as the operator is likely to open the battery compartment, disconnect the battery, and connect it to the charger.

Follow the COSHH advice supplied by the OEM supplier, for covering exposed body parts and ensure the procedure for initiating the charge once connected is followed. This would be in the Battery and/or Charger user manual provided by the OEM supplier.

The same applies to the end of charge, and disconnection which generally involves ensuring the current is not flowing to the battery at the time of parting the DC plugs. Follow the method of ending a charge stated in the Charger User Manual.

The operator risks creating a spark or arc if he disconnects under load, which could trigger an explosion if the gasses present exceed the LEL (Lower Explosion Limit). This could result in damage to the battery and harm to the person causing the explosion, or anyone else in the vicinity.

Follow the safe route of ensuring the charger is terminated or the charge is stopped in a manner which indicates the current has ceased, and allows safe disconnection.

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6 CHANGING

6.1 Driving/Operating the MHE Truck, Charging & Changing the Battery

The contact level again increases, and so will the need for PPE and precautions when in contact with the battery. If it is a spare battery operation then changing is required. Static electricity when making contact with battery parts has to be avoided.

Precautions are required to eliminate static discharge before making contact with the battery, especially the one which has been recently fully charged and gassing.

The next pitfall is trapping and damaging battery cables, which if the inner cores become exposed may cause short circuits, and this can result in damage to batteries and harm to those close by.

Report any damage so it can be eliminated, and isolate batteries until the repairs are carried out, to enable a safe system to be changed.

This applies to battery changing where a manual or mechanical method is used, to extract and fit spare batteries to MHE.

7 MAINTAINING / REPAIRING

7.1 Driving/Operating the MHE Truck, Charging, Changing and Maintaining/Repairing the Battery

This will involve a greater degree of contact with a battery, and should be carried out by trained personnel only, who can manage the environment and ensure those close by do not pose a risk to him/her or themselves.

Maintenance can take many forms, and some are listed below:

Visual checks to see the battery is undamaged, which includes its take-off cables and plug.

A visual check to see that any ancillary item are intact and where possible functioning.

Visual checks to determine if it's time for topping-up (watering) after completing a charge.

This could be via;

- An electrolyte level sensor.
- A float level indication.
- A manual view of the electrolyte by opening a vent plug to see where the tide is visible, and how low it is and what parts are exposed or covered.
- Recording Specific Gravities (SGs) and cell voltages would also be carried out on a fully charged battery, after termination and when voltage stability has been obtained.

This is a different task to recording top of charge (TOC) readings, which should only be performed by highly trained Battery Service Engineers, as a diagnostic function.

If any work is to be carried out on a traction battery, ensure its stopped gassing and degassing of each cell has taken place, if disconnection of any item is to take place.

This is most important if the battery has any charger directly connected across it, without any plugs to decouple it, prior to unbolting a cell cable from its pillar.

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When batteries require repair, it is recommended that original parts are used. The battery has been designed in relation to its capacity and potential working conditions, including electrical load. In some cases design specifications are application specific, and by replacing items of a different specification, you may change the characteristics and alter its ability to support an application.

This also applies to watering systems, where mixing different suppliers should be avoided, on a single battery.

7.2 Bolted Connections

Where battery pillar connections are made via bolts, they are generally a one off use bolt with a set torque when first fitted and a locking agent on their threads. They are not designed to be reused and if removed a new bolt should be used to reconnect the cell to the battery.

The concept is the bolt once fitted will remain in place for the life of the battery, and should not require any further attention. The insulating parts of the bolt also form the seal around t the pillar, keeping corrosive substances away from vital conducting parts, and foreign bodies from causing short circuits.

8 TOPPING-UP (WATERING)

The interval between Topping-Up (Watering) of a lead/acid battery will vary with battery technology, and advice from the OEM supplier should be obtained to ensure the charging/ topping-up regime is understood by those expected to support this activity.

Before any topping-up takes place, a source of water suitable for use in traction batteries has to be obtained. This in some UK areas can be tap water, but in others deionization to remove harmful particles is required.

There is a British Standard (BS 4974:1975 Specification for Water for lead acid batteries) for the purity of water suitable for Traction Batteries, and if a water source is to be used it should comply with that standard.

Topping-up methods generally fall into four categories. All methods are carried out after completing a terminated charge.

8.1 Manual Method

Where it is a visual operation requiring opening of vent plugs to determine the tidal state of the electrolyte after completing a terminated charge. The general rule is if the internal plates are just exposed, then topping-up is required, and it is done to just above the separators.

Dispensing of water can be via a jug or other uncontrolled means of filling the cell. The decision to stop is taken by the person topping-up the cell.

8.2 Float Based System

Each cell has a filling plug connected by pipework to one connection. The water can be delivered by controlled pressure or gravity fed. Each cell plug has a float which operates a valve to shut off the water when the desired level is reached. Any water remaining in the pipework will go into cells when the valve permits. The cell plugs have a visual indication of whether the float is up or down. If it is down after a terminated charge, then topping-up is required, any other time is not a valid view.

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8.3 Pressure System

Where high but controlled pressure is used to deliver the water. Each cell has special plugs which sense the rising electrolyte, and shuts off the water when a determined level is reached. All are connected in a string, following the electrical path of the battery. This type of system uses electrolyte level sensors to display when topping up is required, and only after a terminated charge should it take place.

8.4 Poor Battery Maintenance

Topping-up (Watering) should be part of a controlled maintenance system, operated by trained personnel, who know how to determine when topping-up is required and when it should take place.

Random topping-up will lead to electrolyte loss via over-topping and should be avoided. Equally, the neglect of topping-up should be guarded against as irreparable damage can take place to the internal components of a cell/battery, resulting in early life failure.

9 VENTILATION OF BATTERIES & BATTERY CHARGING LOCATIONS

If the battery is to be charged on the MHE truck, then follow the OEM charging instructions. This generally requires the battery compartment to be open to the atmosphere so that gasses can easily escape and dissipate, so no gas trapping or pockets are formed.

If the battery is on-board or on a spare battery racking system, the area or charging room will require confirmation it is adequately ventilated.

Wherever a battery is charged the atmosphere becomes enriched by oxygen and hydrogen, and it has to be controlled to keep it safe for those operating within or nearby the area.

BS EN 62485-3:2014 Safety requirements for secondary batteries and battery installations – part 3 – Traction batteries – has section 6 – Provisions against explosion hazards by ventilation.

9.1 Natural Ventilation

Section 6 – Provisions against explosion hazards by ventilation, determines if natural ventilation or forced ventilation is required where Traction Batteries are charged. The calculation can be carried out for different cell/battery technologies, and charger types. It can be for one battery or hundreds in one location.

It is based on preventing a build-up of potentially explosive gasses to a level which could explode, and in the case of hydrogen if it exceeds a 4% gas/air mixture. The calculation has safety factors built in, and if followed will keep the atmosphere in a safe state.

It does require air to pass through a traction battery charging area, and it's achieved via openings for air in and air out at least 2 metres apart. This is where to measure the air flow at each to see it is actually taking place. Their minimum area of each is part of the calculation.

The final part of the calculation looks at the volume of free air available for the gasses to mix and dilute. If the volume of free air is below a set level of 2.5 times the volume to move, then forced ventilation is most likely required.

9.2 Forced Ventilation

Forced ventilation can take several forms, from fans bringing air into an area, or suitable fans extracting air from an area, to large trunking systems which extract at various points and take it out of the area, usually to the external part of the building.

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9.3 History & Monitoring

Some of these systems will fall into the LEV (Local Exhaust Ventilation) category depending upon what they are designed to achieve, and it is recommended that any form of ventilation being natural or forced should have some form of history to enable those managing the area and activity to see it is still functioning and valid. When ventilation is commissioned the method of commissioning and readings taken should be part of the documentation left with the end user/manager of the area. This data and method can be used for the periodic testing/validation.

The frequency of such testing/validation will be determined by the ventilations classification, and guidance for this can be obtained from HSE (Health & Safety Executive) website.

9.4 Failure of Ventilation

Where a ventilation system is vital to the running of the battery charging area, some form of alarm is recommended to alert those managing the system, that it has failed and action is required to investigate why.

10 SAFE DISTANCE FROM A BETTERY UNDER CHARGE

BS EN 62485-3:2014 Safety requirements for secondary batteries and battery installations – Part 3 – Traction batteries

Care must be taken when designing a battery charging area, and in the standard Clause 6.5 refers to “Close vicinity to the battery”, and its recommendation is;

In the close vicinity of the battery the dilution of explosive gases is not always secured therefore a safety distance of minimum 0.5m extending through the air without flames, electrostatic discharge, sparks, arcs or glowing objects (max. surface temperature 300°C) shall be observed.

This safe distance from the top of a battery when it is gassing to a source of heat is through the air and can be inclusive of going round shelves or other barriers, to extend the distance. It should also be considered when connecting or disconnecting plugs, to ensure it is not done under load so as to prevent any sparks and arcs taking place.

10.1 A battery monitoring system should be designed and installed in such a way that no hazard will occur during its use in operation, as described in section 10.1 of BS EN 62485-3:2014.

11 VENTED BATTERIES WITH LIQUID ELECTROLYTE

Traction batteries of vented cells with liquid electrolyte do require maintenance, and not just topping-up. Warehousing/logistics can be a dusty application and the surface of cells can become covered with debris from the atmosphere. Cleaning the surfaces of the battery is as important as the topping-up.

As previously stated, neglecting topping-up or doing it at the wrong time can cause overtopping and loss of electrolyte, which will form a conductive layer on top of the cell lids and down into the metal (plastic lined) tray.

This eventually will cause earth leakage from the battery/cell terminals, and in a severe case a short circuit, but before that from cell pole to tray, and this can have an effect on the MHE truck equipment, especially with older trucks which use the chassis as one part of the electrical path.

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Modern MHE trucks do not use the chassis as a conductor and so this effect is not as critical and that is reflected in the Insulation resistance of the battery compared to the truck. The test effectively requires the truck to be 20 times greater in its insulation resistance than the battery.

EN 1175-1:1998 has this information in **Section 5** for trucks/batteries under 120v and **Section 6** for trucks/batteries over 120v.

From a maintenance point of view, cleaning the battery is important and will also protect its vital parts from the corrosive effects of the electrolyte.

Use the COSHH pack which can be obtained from your OEM supplier, which contains the recommended methods of neutralizing any spillages and methods of disposal afterwards. The MSDS (Material Safety Data Sheets) are often the basis of COSHH information and can be obtained from your OEM supplier on request. Ensure you have them before such an event.

11.1 Cleaning Batteries

There are many methods of cleaning batteries starting with a simple absorbent cloth or towel. Some methods involve cleaning agents and it is important to check the MSDS for the hazards when using such agents, and in particular its effects when in contact with Sulphuric acid.

If the agent is used to neutralise sulphuric acid, it is important that it does not enter the cells and affect the electrolyte.

Steam cleaning is another method which can be less invasive, but care has to be taken to ensure components are not subject to temperatures which will result in damage or failure.

Some methods include a form of washing and care must be taken to ensure the liquids do not fill the battery tray, and flood the battery as a result.

12 VRLA (VALVE REGULATED LEAD ACID) BATTERIES WITH GEL & OTHER FORMS OF ELECTROLYTE

12.1 Maintenance Free & Valves

This type of cell/battery is designed to be filled once and never topped-up again for the life of the product. It does not have a conventional vent plug, but has a valve which allows the cell to vent if the internal pressure exceeds a set designed level.

The battery is almost maintenance free as no topping-up is required, but it should still have its surfaces cleaned to maintain its freedom from earth leakage, triggered by any deposit which lands on its surfaces which will provide an electrical path.

12.2 Charging VRLA

VRLA batteries should only be charged on a charger containing and being set on the correct profile, which meets the manufacturer's specification for their product. If the battery is placed on the wrong charge profile, it will overheat and dry-out prematurely resulting in early life failure.

Seek advice from your OEM supplier to ensure the correct charger is in use from the beginning of an application. If you have a mixed fleet of Vented and VRLA batteries, it is essential you are able to tell the difference between a Vented charger and the one for the VRLA product. Some battery/charger connectors have colour coded voltage pegs or the whole plug is coloured to denote the cell technology in use. Your OEM supplier can assist with such options.

12.3 Ventilation when Charging VRLA

BS EN 62485-3:2014 has values for its calculation to cover VRLA batteries under charge, and so provide the openings for air input and output. Less gas is produced from VRLA than Vented batteries, but some is produced and ventilation is required.

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13 ATEX BATTERIES

This is a subject too large and complex to be covered in a Guidance Note. It is important that anyone who encounters an ATEX battery has to remember it is designed for special operating conditions, and where it can be used is displayed on the battery label, and on any MHE truck it is designed to function on.

If an Ex ATEX battery has been damaged in any way, or requires work which involves more that routine maintenance such as cleaning or topping-up, then only trained Service Engineers are allowed to carry out such work.

As a rule of thumb the battery would have to be repaired using only parts from the original supplier to reinstate it to its original standard of certification, and its technical file would require its history updating with any repair via documents supplied by those carrying out such repairs.

In all cases it is essential you contact your OEM supplier where ATEX batteries are the subject.

14 DISPOSAL OF BATTERIES AT END OF LIFE

In the European Community, the Directive 2006/66/EC covers batteries placed on the market and batteries at the end of life. For Industrial batteries there is a ban on disposal via landfill, and they have to be collected and recycled.

Traction batteries come under Industrial Batteries, and when your batteries are at the end of life, contact your OEM/supplier and they will arrange for their pickup and recycling to comply with UK legislation (The Waste Batteries and Accumulators Regulations 2009) based on the EU environmental requirements under the 2006/66/EC directive.

15 GLOSSARY OF TERMS

AC	**Alternating Current**
AGV	**Automated Guided Vehicle**
ATEX	**Atmosphere Explosives**
BS	**British Standard (via BSI)**
BSI	**British Standards Institute**
CENELEC	**European Committee for Electrotechnical Standardization**
COSHH	**Control of Substances Hazardous to Health**
DC	**Direct Current**
EN	**European Standard (via CENELEC)**
EU	**European Union**
Ex	**The symbol associated with ATEX products**
HSE	**Health & Safety Executive**
IEC	**International Electrotechnical Commission**
ISO	**International Standards Organization**
LEL	**Lower Explosion Limit**
LEV	**Local Exhaust Ventilation**
MHE	**Mechanical Handling Equipment**
MSDS	**Material Safety Data Sheet**
OEM	**Original Equipment Manufacturer**
PPE	**Personal Protective Equipment**
SGs	**Specific Gravities**
TOC	**Top of Charge**
UK	**United Kingdom**
VNA	**Very Narrow Aisle**
VRLA	**Valve Regulated Lead Acid**

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