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HIRE INDUSTRY SAFETY GUIDANCE FOR LITHIUM-ION BATTERIES

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1 LITHIUM-ION BATTERY PACKS AND CARTRIDGES UTILISED IN PORTABLE EQUIPMENT AND POWER TOOLS

1.1 General Safety Requirements

- 1.1.1 Before using battery cartridges/battery packs, read all instructions and advisory warning markings on the battery charger, the batteries, and the specific product designed to use the battery cartridge or housing the battery pack.
- 1.1.2 Li-ion batteries are composed of cells that contain lithium-ion storage materials capable of providing high specific energy density. Li-ion cells have a minimal memory effect, but they are very susceptible to external impact, deep discharge, and high temperatures.
- 1.1.3 Damaged or failed batteries can lead to skin irritation, severe corrosive injury, chemical burns, fire and/or explosion.
- 1.1.4 Batteries must be handled with care in order to avoid damage and prevent leakage of fluids that are hazardous to health.
- 1.1.5 Do not under any circumstances modify or tamper with batteries.
- 1.1.6 Do not disassemble, puncture, crush, or incinerate batteries and do not subject them to temperatures over 60°C.
- 1.1.7 Never use or charge a battery that has suffered an impact or been damaged in any other way. Check the battery cartridges or equipment housing regularly for signs of damage or leaking fluids.
- 1.1.8 Never use the battery or a battery-operated power tool as a hammer.
- 1.1.9 Never expose batteries to direct sunlight, elevated temperature, sparking, or open flame. This can lead to fire or explosions.
- 1.1.10 Do not touch the battery poles with your fingers, tools, jewellery, or other electrically conductive objects. This can damage the battery and also cause material damage and personal injury. When the battery pack is not in use, keep it away from other metal objects, like paper clips, coins, keys, nails, screws, or other small metal objects, that can make a connection from one terminal to another. Shorting the battery terminals together may cause burns or a fire.
- 1.1.11 Keep batteries away from rain, moisture, and liquids. Penetrating moisture can cause short-circuits, electric shock, burns, fire and explosion.
- 1.1.12 Use only the compatible charger/s and power tools approved for the specific battery type. A charger that is suitable for one type of battery pack may create a risk of fire when used with another battery pack. Further information should be observed by reading and following the relevant manufacturers operating instructions.
- 1.1.13 Do not use or store the battery or equipment housing the battery in explosive environments.

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- 1.1.14 If the battery, or the equipment casing in which it is housed, is too hot to touch the battery may be defective. Wearing appropriate gloves put the battery in a place where it is clearly visible and where there is no risk of fire, at an adequate distance from flammable materials. Allow the battery to cool down sufficiently. If it is still too hot to touch after an hour, the battery is faulty. Report this immediately to the Hire Company that provided the equipment.
- 1.1.15 If the operating time of a battery cartridge has become excessively shorter, stop operating the battery powered equipment immediately. It may result in a risk of overheating, possible burns and even an explosion.
- 1.1.16 Under abusive conditions (exposure to impact damage or excessive temperatures - heat damage for example), liquid may be ejected from the battery; avoid contact. If accidental skin contact occurs, rinse the affected area immediately with plenty of water. If liquid contacts eyes, irrigate the eye/s with water, additionally seek medical help. Liquid ejected from the battery may cause irritation or burns.
- 1.1.17 In order to optimise battery life; charge the battery cartridge before completely discharged. Always stop tool operation and charge the battery cartridge when you notice less tool power. Never recharge a fully charged battery cartridge. Overcharging shortens the battery service life. Charge the battery cartridge with room temperature at 10 °C - 40 °C (50 °F - 104 °F). Let a hot battery cartridge cool down before charging it. When not using the battery cartridge, remove it from the tool or the charger. Charge the battery cartridge if you do not use it for a long period (for example more than six months).
- 1.1.18 If the tool has a removable cartridge/battery pack the battery should be removed from the tool and stored in the dedicated compartment within the carry case where applicable.
- 1.1.19 Installing the batteries to non-compatible products may result in a fire, excessive heat, explosion, or leak of electrolyte.
- 1.1.20 During and after use, the battery cartridge may take on heat which can cause burns or low temperature burns. Pay attention to the handling of hot battery cartridges.
- 1.1.21 Do not touch the terminal of the tool immediately after use as it may get hot enough to cause burns.
- 1.1.22 Do not allow chippings, dust, or soil to get stuck into the terminals, holes, and grooves of the battery cartridge. It may result in poor performance or breakdown of the tool or battery cartridge.
- 1.1.23 Unless the tool supports the use near high-voltage electrical power lines, do not use the battery cartridge near a high-voltage electrical power lines. It may result in a malfunction or breakdown of the tool or battery cartridge.
- 1.1.24 Batteries must only be charged in a well-ventilated area away from sources of heat, ignition and away from combustible materials, gases, and vapours.

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1.2 Charging

- 1.2.1 Before charging battery cartridges/battery packs, read all instructions and advisory warning markings on the battery charger, the batteries, and the specific product designed to use the battery cartridge.
- 1.2.2 Never charge a battery that has suffered an impact or been damaged in any other way. Check the battery cartridges or equipment housing regularly for signs of damage or leaking fluids.
- 1.2.3 In order to optimise battery life; charge the battery cartridge before completely discharged. Always stop tool operation and charge the battery cartridge when you notice less tool power. Never recharge a fully charged battery cartridge. Overcharging shortens the battery service life. Charge the battery cartridge with room temperature at 10°C - 40°C (50°F - 104°F). Let a hot battery cartridge cool down before charging it. When not using the battery cartridge, remove it from the tool or the charger. Charge the battery cartridge if you do not use it for a long period (for example more than six months). Charging at low temperatures e.g., below 0°C should be avoided as this can damage the battery chemistry.
- 1.2.4 Every Li-ion battery has a minimum cell voltage limit that should not be exceeded. If a battery has been fully discharged during use and it is then placed into storage without being recharged, the battery might drop below this limit which may damage the cell chemistry. Recharging a battery in this condition may cause a thermal runaway event. Therefore, batteries returned at 0%, or low state of charge, should be charged before storage, and where a battery has been in storage for a long period, the voltage should be checked before it is placed onto the charger.
- 1.2.5 Use only the compatible charger/s and power tools approved for the specific battery type. A charger that is suitable for one type of battery pack may create a risk of fire when used with another battery pack. Further information should be observed by reading and following the relevant manufacturers operating instructions.
- 1.2.6 A designated and segregated, suitably ventilated charging area where packs and cartridges can be left on charge should be determined by both a general risk assessment and fire risk assessment. In terms of managing hazards and carrying out a risk assessment for this activity it is reasonable to anticipate that a battery fire might occur, hence suitable control measures and mitigation need to be considered. This may include non-conductive, fire-proof and chemically resistant shelving or benching, fire detection and provision of suitable fire extinguishers, suitable Li-ion fire blankets or fire suppression system / trace system. If the area is enclosed ventilation and removal of battery fumes needs to be considered. It may be worth considering containment of waste-water runoff from extinguishers or sprinklers which may be considered as hazardous waste.

1.3 230 Volt Chargers (13 Amp Square Pin or 16 Amp Blue Plug)

- 1.3.1 A residual-current device (RCD) or residual-current circuit breaker (RCCB) should be used, plugged directly into the 230v socket. The charger should be plugged into the RCD. This will help protect against electric shocks if the cable or equipment gets damaged.
- 1.3.2 The 'TEST' button should be used to check that the RCD is working each time it is used. The RCD should be reset according to the instructions supplied with it.
- 1.3.3 Wherever possible avoid the use of extension cables. If an extension cable is required, follow any special instructions given by the hire company. If the hire company has not given any special instructions, only a suitably rated extension cable should be used, no longer in length than that specified by the manufacturer or as advised by the Hire Company. It should be plugged directly into the RCD.

- 1.3.4 The cable should be laid out carefully, not presenting a trip hazard, avoiding liquids, sharp edges, doorways or windows where it might be trapped, and places where it may be run over by vehicles. It should be unrolled fully or it will overheat and could catch fire.
- 1.3.5 Make sure that any extension cable connections are dry and safe.

1.4 Damaged or Defective Batteries

- 1.4.1 If you suspect that a battery may be damaged or defective in any way, contact the Hire Company that provided the battery equipment immediately.

If a battery is identified as defective whilst in use and is required to be transported back to suitable collection point, advice may first need to be sought from somebody who has the required knowledge to advise how this should be done safely, for example from an appointed Dangerous Goods Safety Advisor (DGSA). Contact either the Hire provider or the Manufacturer for further information.

- 1.4.2 Should you notice any abnormal battery behaviour, such as faulty charging, unusually long charging times, noticeable power loss, operating time has become excessively shorter, unusual LED activity, or leaking fluids, these are signs of an internal problem. Stop operating immediately. It may result in a risk of overheating, possible burns and even an explosion.
- 1.4.3 Do not use a battery that is leaking fluid. A battery that no longer works, cannot be recharged. A battery that is leaking fluid has to be disposed of correctly. Any such circumstances must be communicated to the hire provider as soon as possible.
- 1.4.4 Avoid direct eye and/or skin contact with fluid leaking from a battery. Always wear protective gloves and eye protection when undertaking tasks involving battery fluid. Use a chemical spill clean-up kit to remove leaked battery fluid. Comply with the locally applicable regulations for battery fluid clean-up and disposal.
- 1.4.5 Store the damaged battery in a non-flammable container and cover the battery with dry sand, vermiculite, or chalk powder (CaCO₃). Then seal the lid air-tight and store the container away from flammable gases, liquids, or objects.
- 1.4.6 If you suspect that a battery may be damaged or defective in any way, do not use the battery and contact the Hire Company that provided the battery powered equipment immediately.

1.5 Battery Fires

- 1.5.1 A burning battery releases hazardous and potentially explosive liquids and fumes that can lead to corrosion injuries, burns or explosions. Wear appropriate personal protective equipment when tackling a battery fire. Provide sufficient ventilation to the area to permit hazardous and potentially explosive fumes to escape.
- 1.5.2 Leave the room immediately in case of intense smoke emission.
- 1.5.3 Consult a doctor in case of any skin or respiratory irritation.
- 1.5.4 Alert the fire service before you attempt to tackle a battery fire.

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- 1.5.5 Use only water to tackle a battery fire and keep as far from the fire as effective extinguishing permits. Powder fire extinguishers and fire blankets are ineffective with Li-ion batteries. Only a dedicated Li-ion Fire Blanket will be effective in isolating a Li-ion battery fire. Fire in nearby materials can be extinguished with appropriate extinguishing agents.
- 1.5.6 Do not try to move any quantities of burning batteries. Instead, isolate the batteries by removing unaffected materials from the immediate vicinity. In the case of a battery that does not cool down, or a smoking or burning battery: Scoop the battery up with a shovel and drop it into a bucket of water, which will reduce the risk of igniting adjacent cells that have not yet reached run-away temperature. Leave the battery in the bucket for at least 24 hours until it has cooled down completely.

1.6 Storing and Transporting Batteries

- 1.6.1 Ambient operating temperature to be kept between -17°C and +60°C / 1°F and 140°F. Storage temperature to be kept between -20°C and +40°C / -4°F and 104°F. Do not store batteries on the charger. Always remove the battery from the charger when the charging operation has completed.
- 1.6.2 Store batteries in a cool and dry place. Cool storage will increase battery life. Never store batteries where they are exposed to direct sunlight, on sources of heat or behind glass. Consider storing batteries away from fuel sources such as combustible materials, wooden benches/storage equipment, cardboard, fuels, oils, and gases. If possible, store in an area away from the main building where in the event of a fire this would not effect the wider premises.
- 1.6.3 Transport batteries in manufacturers carry-case wherever possible ensuring that battery packs are correctly housed in the dedicated mouldings within the case. During transport, batteries should be protected from excessive shock and vibration and isolated from any conductive materials that may come in contact with the terminals and cause a short circuit, for example, metal screws or fixings. Comply with the locally applicable regulations for transporting batteries.
- 1.6.4 The contained lithium-ion batteries are subject to the Dangerous Goods Legislation requirements. For commercial transportation e.g., by third parties, couriers, or other forwarding agents, special requirements on packaging and labelling must be observed. It is important to note that lithium batteries have been identified as a Class 9 dangerous good, during transport. To be safely transported (by air, sea, rail, or roadways), they must meet the provisions laid out in Standard UN 38.3.

This standard applies to batteries transported either on their own or installed in a device (UN codes 3090/3091 for lithium, 3480/3481 for lithium-ion). This applies to all points in the battery's transportation process: from sub-suppliers to end-product manufacturer; manufacturer to distributor; in or out of the product; in the field; during product returns or with non-original packaging. For preparation of the item being shipped, consulting an expert for hazardous material is required. Batteries must be suitably secured in approved packaging, and correctly labelled. Tape or mask off open contacts and ensure that the battery cannot move around in the packaging during transportation.

1.7 Maintenance

- 1.7.1 Keep the battery free of fluids, water, oil and grease. Do not permit dust or dirt to accumulate unnecessarily on the battery. Clean the battery with a dry, soft brush or a clean, dry cloth.
- 1.7.2 Never use a battery with clogged ventilation slots. Clean the ventilation slots carefully using a dry, soft brush.

2 LITHIUM-ION BATTERY PACKS UTILISED IN PLANT AND EQUIPMENT (NOT ACCESSIBLE OR INTENDED TO BE HANDLED BY THE END-USER)

2.1 General

- 2.1.1 Lithium batteries are available in a multitude of formats, with manufacturers having varying approaches to design, charging, maintenance and disposal. Given the potential variance, even when lithium batteries appear physically similar it is imperative that owners, users and those responsible for maintenance and disposal understand the specific requirements. These should always be detailed within the equipment documentation, for the hire industry it would always be wise to ensure any important information is communicated via additional decals or hire documents. If any plant /machinery has been reported having collision damage on site, consult the manufacturer as impact damage may result in batteries becoming unstable, potentially leading to fire/explosion.

2.2 Operation

- 2.2.1 The majority of lithium battery systems work without too much intervention from the equipment operator or maintenance teams; in the case of Mobile Elevated Work Platforms (MEWPs) and Mini Excavator produced by leading brand manufacturer's the Battery Management System is a hands-off, intelligent system which self manages itself. On the rare occasion of a system error a code is displayed for the operator, with code explanations contained in the Operator Manual. Typically, these codes do not require any intervention from the operator, the code purely communicates the system status to the operator.
- 2.2.2 For MEWPs and Plant Machinery manufacturer's utilising a 52V system, within the Low Voltage Regulations, attention should be made to the system voltages as these vary across lithium batteries. The voltage may come under different regulation and therefore require training and insurances to work with it.

2.3 Charging

- 2.3.1 Lithium batteries require a dedicated charger, designed, and programmed for the specific battery pack, this must only be replaced with an approved product. Using 3rd party chargers without the correct profile will result in battery damage. Leading manufacturers of MEWP's and Mini Excavators recommend that their products should only be used with their original dedicated battery charger and power cables.
- 2.3.2 Equipment users should follow the charging protocol in the manual and ensure that the power supply is rated correctly for the equipment. Lithium batteries accept charge differently than traditional lead acid batteries, which often allows for opportunity charging. It is key to understand if the equipment requires a full charge on a regular basis, say every 20 charges one must be a full charge. This must be communicated to the operator to ensure battery performance is retained.

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2.3.3 Many systems, used in MEWP's and Mini Excavators automatically manage the maintenance and charge profiles without any additional input from the service team, however if manual maintenance and/or balancing charges are required these should always be added into the equipment service schedule. These requirements will usually be detailed in the equipment documentation. It is imperative that these protocols are followed to ensure the longevity and performance of the battery system. Additional tools may be required to carry out maintenance tasks, such as a specialist charger to bring individual cells up to the required voltage.

2.4 Transportation

2.4.1 The lithium battery packs, such as those used in leading brands of MEWP's and Mini Excavators for example, have been designed to be UN38.3 compliant which covers domestic and international transport. All lithium batteries should display a marking which denotes their compliance with a specific UN code.

2.4.2 In the UK and Europe transportation is regulated by the European Agreement Concerning the International Carriage of Dangerous Goods by Road: ADR 2015, the International Civil Aviation Organization (ICAO), Technical Instructions and corresponding International Air Transport Association (IATA), Dangerous Goods Regulations, and the International Maritime Dangerous Goods (IMDG) Code, UN38.3 is accepted for all of these bodies.

2.4.3 In addition to the testing requirements, there are regulations on how these cells and batteries must be packed for safe transport. Different requirements apply depending on the mode of transport, the highest level of packaging is required for air transport, detailed information transport can be sourced from the battery / equipment manufacturer. Always communicate this with any freight forwarder to ensure correct transportation.

2.4.4 When moving lithium batteries within own vehicles, whether installed on the machine or as a spare part, then manufacturers advice must be followed. Insurers should always be consulted as transporting a battery out of equipment may be treated differently to the transport of a lithium battery as part of a machine.

2.5 Storage and Disposal

2.5.1 Lithium batteries have specific storage instructions, failure to follow these may result in the battery being unusable or increase the risk of fire or contamination. Correctly stored lithium batteries, following manufacturer guidelines, can be stored safely and cost effectively.

2.5.2 If equipment is expected to be stood down, then the battery isolation and storage protocol should always be followed. Stored batteries should be added to a register with any periodic requirements listed to ensure they are carried out.

2.5.3 Some leading manufacturers of MEWP's recommend that lithium battery packs utilised for access platforms should be checked for voltage every 3 months whilst stored with actions taken according to the result. A correctly maintained pack, kept in the right conditions could be stored for in excess of 10 years – in comparison the same pack incorrectly stored would have no more than 2 years before being beyond recovery. Some leading manufacturers of Mini Excavators and Small Dumpers recommend checking the battery pack once every month and ensuring state of charge is greater than 50%. Check the manufacturers specific operator's manual for further details.

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- 2.5.4 The storage area should be determined by the manufacturer guidelines and fire risk assessment, many specify temperature restrictions and advise if the batteries should be stored away from specific items. Always read the manual and familiarise yourself with the storage requirements, in addition consult with your insurer to clarify any policy determined requirements.
- 2.5.5 Disposal of lithium batteries should be in accordance with manufacturer guidelines. Waste carriers will also have specific advice regarding collection and disposal. Leading manufacturers of MEWP's and Mini Excavators offer a free disposal service for the lithium batteries within their product range, to ensure the batteries are recycled in the most environmentally friendly manner and to utilise them in other applications such as energy storage if applicable.

2.6 Summary

- 2.6.1 The lithium battery systems adopted by leading manufacturers of MEWP's and Mini Excavators have been purposely designed to minimise intervention from the operator or service team, with specific storage and transport instructions to ensure safety and protect the lifetime of the product. Upon delivery customers are taken through a detailed handover to ensure a comprehensive understanding of the product. However, not all battery systems are the same, it is imperative that all owners and operators ensure they are familiar with the specific requirements of the lithium battery within their equipment. Failure to do so may result in significant costs and increase the risk of damage to the battery system and /or other property.
- 2.6.2 Hirers should ensure that any critical information is well communicated within hire documents and handovers and any maintenance is included in service schedules.
- 2.6.3 Insurers should be consulted as to storage, maintenance, and transport to ensure the policy is correct and specific requirements are met.
- 2.6.4 Specific training and updates should be available to appropriate staff. Toolbox talks are recommended as a frequent reminder of the requirements.

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