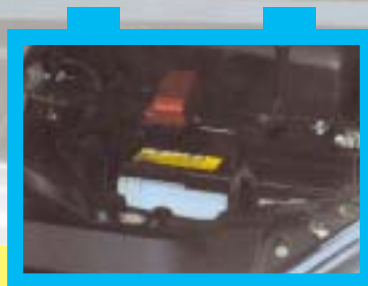


Guidance Notes on Safety and Health at Work –

Use and Maintenance of Rechargeable Battery



Occupational Safety and Health Branch
Labour Department



OCCUPATIONAL SAFETY & HEALTH COUNCIL

This Guidance Notes is prepared by
the Occupational Safety and Health Branch,
Labour Department

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1. INTRODUCTION

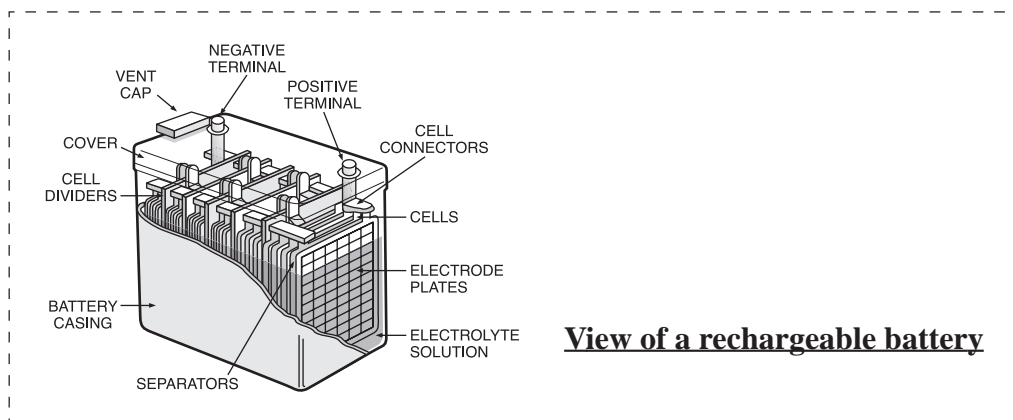
- 1.1 This Guidance Notes offers advice and guidance on the safety and health associated with the handling, usage, charging and maintenance of rechargeable batteries (hereinafter called "the battery work") used for industrial purposes such as automotive batteries for vehicle starting, traction batteries, stationary batteries for standby power supply and batteries for remote-area power supply. It covers the lead-acid and the alkaline electrolyte (nickel-cadmium) types.
- 1.2 For the purpose of this Guidance Notes, the word "battery" will be used to represent both cells and batteries unless otherwise indicated.
- 1.3 This Guidance Notes does **not** cover:
 - the design and construction of the batteries;
 - the manufacture, storage, repair, disassemble and disposal of the batteries;
 - the use of batteries in potentially explosive atmospheres;
 - primary batteries; and
 - small storage capacity rechargeable batteries for watches, portable communication devices, portable power tools and other domestic uses, etc.
- 1.4 The target readers of this Guidance Notes are the workers, their supervisors and the safety practitioners associated with the battery work.
- 1.5 Without implementing and following a safe system of work, workers associated with the battery work are vulnerable to various safety and health hazards. There are accident cases that workers are injured due to improper carrying out of the battery work.
- 1.6 Readers' attention is also drawn to the relevant legislative requirements under the provisions of the Occupational Safety and Health Ordinance (Cap. 509) and Factories and Industrial Undertakings Ordinance (Cap. 59) and their subsidiary legislation administered by the Labour Department.

2. BASICS OF RECHARGEABLE BATTERY

- 2.1 A battery is a chemical device used for the generation or storage of electricity. Primary batteries utilize their stored chemical energy once in a single discharge and are then discarded. Secondary batteries, on the other hand, can be brought back to their initial (charged) condition after discharge by passing a current through them in the reverse direction to that of discharge and are usually called "rechargeable batteries".

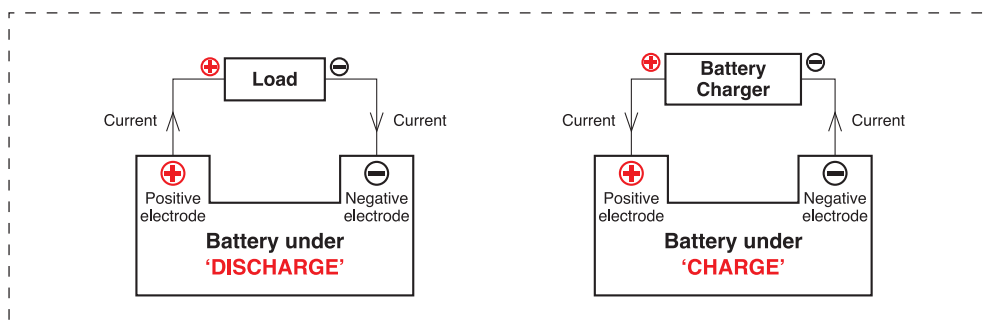
2.2 Basic construction

- A cell is the basic unit of a battery and a battery is formed by joining together in series or parallel two or more electrolytic cells electrically to achieve the rated voltage and capacity. Basically, an electrolytic cell consists of a positive electrode and a negative electrode separated by an electrolyte. Majority of battery electrolytes are aqueous solution of acids, alkalis or salts.



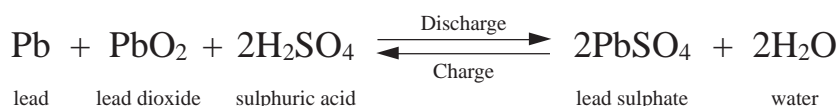
- It is common that a rechargeable battery has a number of electrode plates of the same polarity joined together in parallel and immersed in the same electrolyte. The parallel plates of each polarity are interleaved to increase the storage capacity (ampere-hours) and to keep battery size to a minimum.

- 2.3 The diagrams below show the basic operation of a rechargeable battery under discharge and charge conditions.



2.4 Lead-acid battery

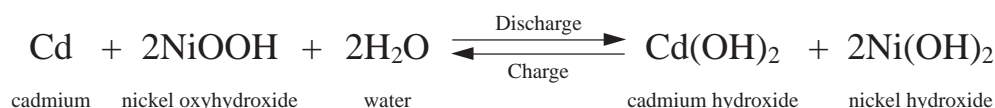
- A lead-acid cell has an acidic electrolyte of sulphuric acid (H₂SO₄), and electrodes having active materials:
 - (a) positive electrode: lead dioxide;
 - (b) negative electrode: lead (spongy metallic lead).
- The overall cell reaction of typical lead-acid cell is:



The nominal cell voltage = +2V

2.5 Alkaline battery (Nickel-Cadmium battery)

- A nickel-cadmium cell has an alkaline electrolyte, usually potassium hydroxide (KOH), and electrodes having active materials:
 - (a) positive electrode: nickel oxide (nickel oxyhydroxide);
 - (b) negative electrode: cadmium (metallic cadmium).
- The overall cell reaction of typical nickel-cadmium battery is:



The nominal cell voltage = +1.2V

3. DUTIES OF PROPRIETORS AND WORKERS

3.1 Overview

- To secure the safety and health for the battery work, it requires the full commitment and co-operation of both the proprietors and the workers.

3.2 Duties of proprietors

- It is the duty of every proprietor to ensure, so far as is reasonably practicable, the safety and health at work of all workers. The proprietors should demonstrate the commitment in managing safety and health and bear the final responsibility and accountability for the safety and health in the workplace.
- The duties of a proprietor include, but not limited to, the following:
 - (a) to manage safety and health in the workplace, and to provide the necessary resources;
 - (b) to ensure that the responsibilities for managing safety and health are appropriately assigned, and the duties are effectively carried out by the workers concerned;
 - (c) to assess the risk at work, and to establish and implement appropriate safety measures for the work;
 - (d) to provide suitable and safe plant and equipment for the work, and to ensure that the plant and equipment are regularly checked and properly maintained;
 - (e) to establish and implement safety rules and safe working procedures for the work;
 - (f) to provide necessary information, instructions and training to the workers, and to ensure that they follow the safety rules and safe working procedures at work strictly;
 - (g) to ensure that only workers who are competent by reason of their knowledge, training and practical experience, are allowed to carry out the work;

- (h) to establish and implement emergency response plans and conduct drills regularly; and
 - (i) to review and revise as appropriate the safe system of work from time to time.
- The proprietor often employs management personnel such as managers, engineers, safety personnel, foremen or supervisors to act on his behalf for managing safety and health in the workplace. The management personnel should effectively discharge their supervisory and management duties to ensure the safety and health at work of the workers. In this regard, the authority and responsibility of each management personnel should be precisely set out and made known to all persons concerned.

3.3 **Duties of workers**

- The workers are required to take reasonable care for the safety and health of themselves and others who may be affected by their acts or omissions at work. The workers are also required to co-operate with their proprietors and the management personnel whenever necessary to enable them to comply with the legal duties imposed on them.
- The duties of a worker include, but not limited to, the following:
 - (a) to understand and act in accordance with the safety rules, safe working procedures and emergency response plan;
 - (b) to make full use of the safety equipment and personal protective equipment provided, and to report any equipment defect to the management/supervisor immediately;
 - (c) to provide feedback to the management/supervisor on the effectiveness of safety measures, safe working procedures and emergency response plans; and
 - (d) to report to the management/supervisor all hazards observed, defects identified or accidents incurred at work.

4. SAFETY AND HEALTH HAZARDS

4.1 The hazards associated with the battery work can be grouped into the following major categories:

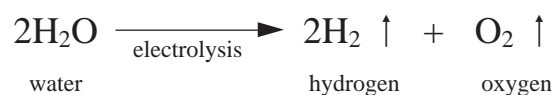
- electrical hazards;
- fire and explosion hazards;
- chemical hazards; and
- other related hazards.

4.2 Electrical hazards

- There are two major electrical hazards in connection with the battery work, namely, electric shock and short circuit of live electrical conductors.
- Electric shock may occur when one makes direct contact with the exposed battery terminals stayed at different potential or the exposed conductor of cables or conductive parts connected with the battery and result in passing of electric current through the body of the victim.
- Short circuit of the battery terminals or other electrical conductors stayed at different potential would cause a high current flow. The sudden release of energy stored in the battery in short time and under an uncontrolled manner may cause a flashover and explosion and result in the rupture of battery housing, spillage of electrolyte, melting down of battery terminals or other metal parts and subsequent splashing of molten metal, etc.

4.3 Fire and explosion hazards

- During the charging of a secondary battery, in particular, when the charging operation is close to completion, explosive gas may be generated from the battery due to the action of electrolysis of water contained in the electrolyte solution.



The gases produced are hydrogen and oxygen. The former is much lighter than the air and would accumulate in the air space above the electrolyte solution inside the battery. These gases may also leak through the battery vents and disperse to the surrounding of the battery room or workplace.

- Hydrogen gas when mixed with oxygen or air can be explosive. Any spark or naked flame present may cause a fierce explosion of the explosive mixture. Sparks may be generated by electrostatic discharge, abrasion of some metals, normal switching or abnormal tripping of electrical equipment, etc.
- Oxygen gas on the other hand would support combustion. A smouldering burn may turn into a blaze in the presence of enriched oxygen. Any grease in the vicinity, which is not ignited in the air normally, may ignite by itself in the presence of enriched oxygen.

4.4 **Chemical hazards**

- Chemicals commonly used in rechargeable battery that are hazardous to health include:
 - (a) sulphuric acid and potassium hydroxide as the electrolyte solutions;
 - (b) lead, nickel and cadmium and their compounds as the electrode plates and materials.

The acid and alkaline electrolyte solutions are corrosive and hazardous when they come into contact with the skin and eyes whereas the latter chemicals are harmful.

- Under normal circumstances, it would be unlikely that workers would ingest or inhale the hazardous chemicals during the normal use and maintenance, rather than the manufacture, breaking, disassemble and disposal, of rechargeable battery. Anyhow, if suitable and sufficient precautionary measures such as ventilation, personal protection, housekeeping and personal hygiene are not practised, the hazardous chemicals may still be ingested through contaminated food and drinks, and acid mist may be inhaled during battery charging.
- Workers may suffer from skin burn or eye injury caused by spillage or splashing of electrolyte if they mishandle or improperly maintain the rechargeable battery.

4.5 **Other related hazards**

- There are other work related hazards associated with the battery work. These include, but not limited to, the following:
 - (a) falling from height of workers when handling battery installed at high level;
 - (b) tripping due to tangling of electric cables during charging of battery or hand tools placed on the floor; and
 - (c) musculoskeletal disorders resulted from the improper handling of batteries that are usually heavy.

5. RISK ASSESSMENT

- 5.1 Risk assessment for the battery work is to evaluate the likelihood of causing harms by the safety and health hazards associated with the work mentioned in Sections 4.1 to 4.5 and the severity of these harms. The risk assessment provides the necessary information for establishing the appropriate safety measures, safe working procedures and emergency response procedures before commencing the battery work. The scale and depth of the risk assessment would depend on the working conditions, working environment and complexity of the battery work.
- 5.2 The basic steps in risk assessment include the following:
- to identify the hazards;
 - to consider who may be affected and how;
 - to evaluate the risks arising from the hazards, and to consider whether the existing safety measures are adequate or more should be taken;
 - to record the risk assessment findings; and
 - to review the risk assessment from time to time and to re-conduct if necessary.
- 5.3 The risk assessment should be specific to the work task. Factors to be considered in assessing risks associated with the battery work include, but not limited to, the following:
- the type of rechargeable battery to work on;
 - whether incompatible chemicals used as electrolyte for different types of rechargeable batteries are present in the same workplace, e.g. sulphuric acid and alkali, which, if come into contact, may result in violent chemical reaction;
 - the type of work to be carried out;
 - the strength of the working team and competence of the team members;
 - the working environment, including
 - (a) whether ventilation and lighting of the workplace is suitable and adequate;
 - (b) whether there is naked flame or hot work;

- (c) whether the process, equipment or tools would generate sparks;
- (d) whether working at height is necessary;
- (e) whether access to and egress from the workplace is suitable and adequate;
- (f) whether the workplace is congested or restrictive; and
- (g) whether the workplace is hot, damp or dusty.

5.4 The risk assessment should be conducted by a competent person who possesses the appropriate knowledge and experience on battery work, and has been suitably trained on the job of risk assessment. The person should be familiar with the work, able to identify the safety and health hazards associated with the work under the particular working conditions and working environment, evaluate the risk associated with the work and recommend suitable and adequate safety measures to ensure the safety and health of the workers.

5.5 The risk assessment should be reviewed regularly. Whenever there has been a significant change in the working conditions, working environment or particulars of the work, the risk assessment should be re-conducted.

6. SAFETY PRECAUTIONS

6.1 Safe system of work

- Failure to suitably and adequately plan ahead for the safe battery work is the fundamental cause of many accidents.
- Adequate information, including manufacturer's instruction manuals about the rechargeable batteries, should be made available to facilitate the planning and development of a safe system of work for the battery work.
- The safe system of work should include a set of safety rules and procedures commensurate with the battery work to be carried out. The established safety rules or procedures should be made known to all workers engaged in the work. It has to ensure that they do understand and would follow the safety rules and procedures at work.
- Only workers, who have received proper training and have the relevant knowledge, experience and understanding of the safety rules and procedures, should be allowed to carry out the work. It has to ensure that the workers always comply with the safety rules or procedures strictly at work. The supervisor should carry out periodic checks on the work to ensure that the workers adhere to the safety rules or procedures.
- The workers should be supplied with tools, materials and personal protective equipment suitable for the work, and other necessary information as laid down in the safety rules and procedures. Hand tools should be of the insulated type to prevent short circuit and they should be spark free. Personal protective equipment to be used would include face shield, gloves, footwear, aprons etc.

6.2 General safe practices

- Before carrying out battery work, the workers should adopt the following:
 - (a) Remove any metallic ornament such as watches, rings, necklaces, etc.
 - (b) Wear suitable personal protective equipment, for example, gloves, aprons, goggles, safety shoes, etc. when working on batteries.
 - (c) Read and follow the manufacturer's instructions on the use and maintenance of the batteries.

- The workers and the supervisor should also check that all the tools, equipment and materials to be used for work are ready; the working environment (i.e. ventilation, lighting, exits, etc.) is suitable; emergency equipment such as eye wash bottles and shower is ready, etc.
- First-aid facilities and suitable fire fighting equipment should be made readily available. For details, please refer to Sections 6.11 & 6.13.
- Suitable warning notices regarding hazards associated with the battery work and precautions to be taken should be displayed in conspicuous places in the battery room and the workplace.

6.3 **Safe use of batteries**

- Any misuse of the rechargeable batteries not only would reduce their working life but may also cause accidents. Apart from the warnings and instructions contained in the manufacturer's instruction manuals, the followings are the general guidance on the safe use of rechargeable batteries:
 - (a) Do not overcharge or over-discharge the battery. When a vehicle is to be put out of service for a long time, its battery should be charged periodically;
 - (b) Keep the batteries away from naked flames or hot work as there may be explosive gas;
 - (c) Do not use old and new batteries together nor rechargeable and primary batteries of different types and capacities. Moreover these batteries should not be mixed together;
 - (d) Do not let the battery electrolyte run short. Top up, but not overfill, the battery with distilled water;
 - (e) Keep the battery top clean and dry and keep the vent caps tightly closed;
 - (f) Avoid any loose or dirty connections of batteries as that may cause local hot spots when the batteries are in use; and
 - (g) The batteries should be correctly installed on stable and level foundation/support and securely fastened in position. Sufficient clearance between batteries is recommended to allow a free flow of air.

6.4 Charging of battery

- Only rechargeable type battery can be charged. Never charge a primary battery as that may cause an explosion or fire.
- Except for some types of batteries e.g. gas-tight "maintenance free" batteries, charging of batteries would generate the undesirable hydrogen and oxygen gases, which may cause fierce explosions when mixed with the air in the presence of naked flame, sparks or other ignition sources.
- The followings are the precautions to be taken to prevent gas explosion, electric faults and other accidents during battery charging:
 - (a) Charging of batteries should be carried out in designated area in the workplace used exclusively for the purpose;
 - (b) Suitable and adequate ventilation should be provided and maintained in the battery room and in designated area in the workplace used for battery charging so as to prevent any accumulation of explosive gases. Unless there is reliable and adequate natural ventilation, mechanical ventilation should be provided in the battery room and the workplace. In particular, local exhaust ventilation (LEV) should be provided in designated area in the workplace used for battery charging;
 - (c) The power supply source for the mechanical ventilation and LEV systems should be reliable. The battery charging operation should be stopped if the mechanical ventilation and LEV systems are faulty. The ventilation equipment used in those areas having foreseeable hazard of accumulation of explosive gases should be of the explosion proof type;
 - (d) Smoking and naked flame are prohibited in battery room, designated area used for battery charging and in the workplace where rechargeable battery is present. It should be borne in mind that explosive gases may not only be evolved when battery charging is in progress. Some gas bubbles generated during charging would stick on the electrode plates of battery and they would be released slowly from the battery for some time subsequent to the charging operation. As such, it should be assumed that explosive gases are always present in the space surrounding the battery top;

- (e) Suitable and adequate lighting should be provided and maintained for the battery room and the workplace. The lighting and electrical appliances used in those areas having foreseeable hazard of accumulation of explosive gases should also be of the explosion proof type;
- (f) The battery charger should be suitably rated and protected against electrical faults. The cable connection terminals should be properly shrouded to prevent accidental short circuit of conductor parts and electric shock;
- (g) The battery charger should be switched off or disconnected from its power supply before making connection with battery cables for battery charging and disconnection of battery cables after battery charging;
- (h) Check that the polarities of terminals of the battery and the battery charger are correct before connecting the two for charging. The positive (+ve) terminal of the battery should be connected to the positive (+ve) terminal of the charger, and the same applies to the negative (-ve) side;
- (i) Due to the large charging current, any sudden breaking of the charging circuit whilst battery charging is in progress may generate sparks at the point of breaking. The charger cables should therefore be firmly and securely fixed or clamped in place on the cable terminals and connections before switching on the charger. Do not disturb the cable terminations and connections whilst battery charging is in progress or when a battery is on load. Switch off the battery charger or the loads of a battery circuit first if any work on the battery cable terminations and connections is required;
- (j) Charging cables and other electric cables should be properly placed. Do not leave these cables tangling freely on the floor to prevent tripping over; and
- (k) Hand tools and electric tools, which might give rise to sparks, should not be used in the vicinity of the battery under charging.

6.5 **Cleaning of battery**

- The battery should be regularly cleaned to remove dirt or salt encrusted around vent cap openings or surface of the battery. The battery can be cleaned by wet towels if it is not too dirty. Otherwise, it should be moved to a designated area with proper drainage and the dirt or salt can then be rinsed out with water.
- In general, do not use chemicals or other solvents as cleaning agent. Also do not use high-pressure water jet to wash the batteries.
- All covers and caps of the cells should be tightly closed before cleansing to prevent any seeping of water into the battery.

6.6 **Handling of battery**

- Batteries are heavy and awkward to handle in general. It may cause musculo-skeletal disorders for the workers if they do not handle the batteries properly. Hence, suitable handling methods should be devised. Suitable lifting points and mechanical lifting equipment should also be provided and made use of. Reference should be made to Part VII of the Occupational Safety and Health Regulation (Cap. 509A) and the Guidance Notes on Manual Handling Operations issued by the Labour Department for developing the safe handling procedures suitable for the work.
- The mechanical lifting equipment used, if applicable, should be tested, examined and inspected according to the requirements of the Factories and Industrial Undertakings (Lifting Appliances and Lifting Gear) Regulations (Cap. 59J).
- Suitable working platform or other suitable means of support and suitable lifting equipment should be provided to allow making access to and handling of batteries installed at high level. The weight of batteries should also be taken into account in the design and construction of the platform and support if the batteries are to be loaded onto the platform and support temporarily.
- When handling batteries, care should be taken to avoid spillage of electrolyte. The battery should be kept in an upright position and the vent caps should be closed tight.

6.7 Electrical safety

- To avoid electrical hazards associated with the battery work, i.e. short circuit and electric shock, the following general principles should be taken:
 - (a) To avoid getting an electric shock, the worker has to take due care to avoid making contact with the battery terminals directly or through other conductive parts, such as the battery cables connected with the terminals, indirectly.
 - (b) To avoid short-circuiting the battery, it should not allow any bridging of battery terminals of different potential by conductive metal parts, both directly or indirectly to form a closed circuit.
- The battery cables and terminals should be suitably rated and sized to avoid any overheating and overloading problem. The bolted connection of the cables and terminals should always be kept tight. It is preferred to have the battery cable connections standardized by using plug and socket type connection units to facilitate easy connection with the battery charger or other batteries. Terminals of the connection units should preferably be of the recessed type so as to minimize the exposure of conductive metal parts.
- The battery cables should be suitably insulated and protected against short circuit and earth fault. The cable terminations should be properly shrouded to prevent accidental contact with the exposed conductive metal parts.
- The workers, who carry out the battery work, should be well aware of the electrical hazards involved. They should take necessary precaution to avoid accidental short circuit and earth fault in the course of work.
- The battery top should always be kept dry and clean to avoid short circuit of the battery terminals or any leakage of current between the terminals caused by the dirt accumulated on the battery top.
- Do not place any conductive parts or metal tools on the battery top.
- All the hand tools used on batteries should be of the insulated and single-ended type. They should be checked regularly to ensure the integrity of the insulation. A numerical check should be made on the number of tools after working on batteries.

- In general, always put the insulation cover or cap of battery terminals, if any, in place to avoid the unnecessary exposure of the bare metal terminals. If the insulation covers or caps are to be removed to facilitate work, the extent and duration of exposure of the terminals should be minimized as far as practicable. In this respect, an insulation plate or barrier may be put on top of the battery to screen off the exposed metal terminals temporarily.
- In case the voltage level of the battery, battery charger or the associated electrical equipment exceeds 120 V d.c., some additional safety precautions should be taken to ensure electrical safety at work. In this respect, reader's attention is drawn to the legislative requirements under the provisions of the Factories and Industrial Undertakings (Electricity) Regulations (Cap. 59W) administered by the Labour Department and the Electricity Ordinance (Cap. 406) and the subsidiary regulations administered by the Electrical and Mechanical Services Department.
- Do not expose the batteries and the battery chargers to rain or water dripping, say from condensate of air conditioning system, to prevent short circuit.
- Thoroughly check the electric cables for the battery and chargers periodically. There should not be any damage of insulation cover that expose the inner cable conductor, reduction of effective cross-sectional area of cable conductor due to breaking of some conductor strands, sign of overheating such as discolouring or charring of cable insulation cover, etc. Any defective battery cables should be repaired or replaced immediately to avoid any short circuit or earth fault.
- Warning notice regarding electrical hazards should be prominently posted in the workplace having the battery, battery charger and associate electrical equipment installed.
- The batteries and the connected cables should be suitably placed and arranged so as to avoid any short circuit of the battery terminals directly or via the cables indirectly. In that respect, sufficient clearance should be allowed between the battery terminals and cable connections of different potential.

6.8 Battery electrolyte

- Electrolytes used in rechargeable batteries are sulphuric acid for lead-acid battery and potassium hydroxide for nickel-cadmium battery. Both of the electrolytes are corrosive and would cause irritation and severe burns if they incidentally come into contact with skin or eyes. The consequence could be very serious.
- The battery mounting rack or cubicle should be of robust construction to withstand the battery loading. It should also be suitably treated for resistance to the corrosive electrolyte.
- To prevent electrolytes from coming into contact with workers, the following precautions should be taken:
 - (a) Handle the batteries with extreme care and keep them in an upright position;
 - (b) Wear suitable personal protective equipment (PPE) such as face shields, gloves, footwear and aprons whenever contact with electrolytes is possible, e.g. measuring the specific gravity of the battery electrolyte, topping up the battery electrolyte. The PPE should be made of materials resistive to acids and alkali, e.g. rubber or nitrile gloves, rubber aprons, etc;
 - (c) All the PPE should be washed thoroughly after use and stored properly in cool and dry place. They should not be exposed to direct sunlight. Check whether there are any defects in the PPE every time before use;
 - (d) Top up the electrolyte with distilled water slowly. Do not overfill to prevent spillage;
 - (e) In topping up electrolyte, only distilled water should be added to the electrolyte but not the electrolyte itself. In case the specific gravity of the electrolyte is still low and could not be raised to normal level after repeated charging of the battery and electrolyte has to be added, only properly trained and experienced workers should be allowed to do so; and
 - (f) Do not add water or electrolyte when battery is being charged.
- A violent chemical reaction may result if strong acid (e.g. sulphuric acid) and strong alkaline solutions (e.g. potassium hydroxide) come into contact with each other. The chemical reaction would release lots of heat and may cause boiling and splashing of the solutions.

- To avoid the above undesirable chemical reaction, never mix the lead-acid batteries and alkaline batteries together. In this respect, it is recommended that:
 - (a) different types of batteries should be installed in different rooms, or in different areas of the room with suitable segregation;
 - (b) suitable warning notice or labels should be posted at conspicuous place to alert the workers should different types of battery be installed in the same room or area;
 - (c) different sets of maintenance tools such as hydrometers, funnels, etc., should be dedicated for different electrolyte. Otherwise, the tools should be thoroughly cleansed with water immediately after use; and
 - (d) workers should be assigned to work on one type of battery at one time as far as possible. Otherwise, suitable washing facilities should be provided to enable the worker to thoroughly clean his hands and protective clothing after working on one type of battery and before working on the other type.

- In case of spillage of electrolyte, the spillage should first be contained by absorbents, spill berm, etc. that are made of suitable materials. Then suitable neutralizing agent should be applied to neutralize the electrolyte:
 - (a) in case of acid spillage, neutralize with a weak alkali, e.g. soda ash, sodium carbonate or sodium bicarbonate;
 - (b) in case of alkali spillage, neutralize with a weak acid, e.g. boric acid.

- Should the spillage is minor and if proper floor drain is available, one may consider diluting the electrolyte spillage by ample amount of water. But before taking such action, he should consider also the possible adverse effects of the acid or alkaline solution on the drainage facilities and other downstream facilities and the environment. Depending on the scale of electrolyte spillage, he may need to solicit experts to deal with the spillage properly.

- One should properly wear suitable personal protective equipment such as gloves, apron, face shield, safety shoes, etc. before he manages the electrolyte spillage. In case the electrolyte comes into contact with his skin or eyes, first aid facilities as described in Section 6.13 should be applied immediately.

- If it is necessary to store electrolytes in the workplace, they have to be kept in proper containers and storerooms and be suitably labelled. The labels should include the following information in both Chinese and English and relevant symbols:
 - (a) identity of the substance – chemical name(s) or common name(s);
 - (b) hazard classification and symbols;
 - (c) indication of the particular risks inherent in the substance; and
 - (d) indication of the required safety precautions.

6.9 **Lead, Cadmium, Nickel and their compounds**

- Chemicals used to make the cell electrode plates including metals such as lead, cadmium and nickel and their compounds are toxic and would impose health hazard to workers if they incidentally enter the worker's body. Therefore as general precautionary measures to protect against the chemical hazards on health, the workers working on batteries should wear suitable personal protective equipment such as gloves. They should also observe good personal hygiene practices such as refraining from eating, drinking and smoking in the workplace, thoroughly washing their hands and faces when taking breaks, before eating and drinking, and after work, etc.
- Since hazardous chemicals are contained inside the battery, the worker should avoid breaking up or damaging the battery casing, which would expose the battery's internal active materials. He would be vulnerable if he touches or somehow ingests or inhales the active materials. Strict personal hygiene precautions should be taken and proper PPE should be worn in extreme case where damage of battery does occur and the active materials are exposed.
- It is essential that all obsolete or damaged batteries, battery casings, containers, electrolyte, electrode plates, and other components that contained hazardous chemicals such as acid, alkali, lead, nickel, cadmium and their compounds, etc. should be properly collected, labelled and stored for subsequent disposal in accordance with the relevant legislative requirements and guidelines issued by the relevant authorities. They should never be mixed with and disposed of as normal domestic waste.

6.10 **Housekeeping**

- Good housekeeping in the workplace is essential in ensuring the safety and health of workers. It is found from past experience that having bad housekeeping is in fact the fundamental cause of a lot of accidents that involve the battery work.
- The following should be noted for good housekeeping in the workplace:
 - (a) Loose materials or tools should be placed in boxes or proper containers instead of being left on the floor freely.
 - (b) Sufficient working space should be allowed. Access ways and emergency exits should always be properly maintained and kept clear from obstructions.
 - (c) Suitable and adequate general lighting and ventilation should be provided and maintained in the workplace. The installation to work on should be well lit with illumination level suitable for the specific work task.
 - (d) Battery rooms should not be used as storerooms, particularly for storing combustible or flammable materials.
 - (e) Battery rooms and the workplaces should always be kept clean, tidy and dry. Rubbish and waste produced should be removed regularly.
 - (f) Personal belongings of the workers should be kept in lockers instead of being scattered around the workplace.

6.11 **Fire protection**

- Suitable and adequate number of fire extinguishers and other fire fighting equipment should be made available in the workplace. These equipment should also be kept in readily accessible locations.
- It should be noted that water type fire extinguisher may not be suitable as it may cause short circuit of the batteries. Carbon dioxide, dry powder type or other suitable type fire extinguisher should be used instead.
- The locations of the fire extinguishers and other fire fighting equipment should be made known to the workers.

- The workers should be trained on the proper use of fire extinguishers and other fire fighting equipment.
- The workers should only try to control the fire when it is small. Otherwise, they should evacuate from the workplace immediately and call the fire services and other emergency services.

6.12 **Personal hygiene**

- Eating, drinking and smoking should be strictly prohibited in the workplace and battery rooms.
- Workers should strictly adhere to good personal hygiene practices to prevent ingesting any contaminated food and water.
- Workers should thoroughly wash their hands and scrub their fingernails whenever a work break is taken for tea or meal and at the end of a day's work.

6.13 **First aid**

- Eye wash bottle and emergency showers should be provided at convenient locations in the workplace for the use of workers in case their skin or eyes are accidentally in contact with the electrolyte. If the electrolyte comes into contact with the skin, it should be washed out with plenty of clean water immediately. If the electrolyte splashes into the eye, flood the eye immediately with plenty of clean water, preferably from an eye wash bottle. Following the washing of skin or irrigation of eyes, medical advice should be sought immediately.
- The eye wash bottles should be checked periodically to ensure that they are not expired, the solutions not cloudy and the seals not broken. The bottles should be replaced regularly in accordance with the manufacturer's instructions. The emergency showers should be turned on regularly to prevent development of rust or accumulation of dirt in the shower and pipework due to prolonged lack of usage.
- If electrolyte is swallowed, do not induce vomiting. It is essential that the worker be made to drink plenty of water and medical attention should be sought immediately.

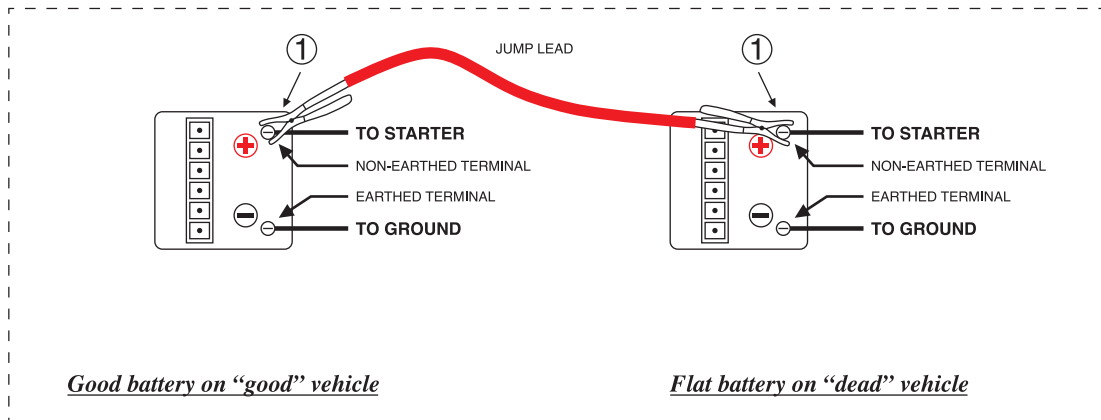
6.14 **Jump-starting a car battery**

- Due to a number of reasons, a car battery may become weak or flat so that it could not crank the car engine. In such a situation, jump-starting a flat car battery may be required.
- Jump-starting is the process of connecting a flat car battery to a fully charged battery of another car or the service vehicle. The connection of the two batteries must be done in a specific way to avoid damage or explosion of the batteries and to prevent damage to the electrical system of both vehicles.
- Jump-starting involves the following four procedures:
 - (a) initial preparation;
 - (b) connection steps:
 - (i) for vehicles with same earth polarity, or
 - (ii) for vehicles with different earth polarity;
 - (c) starting; and
 - (d) disconnection steps.
- **Initial preparation**
 - (a) Make sure that both batteries have the same voltage rating.
 - (b) If starting is done by using a battery of another vehicle, check the earth polarity on both vehicles.
 - (c) Make sure that the vehicles are not touching each other.
 - (d) Turn off the ignition of both vehicles.
 - (e) Always use purposely made, colour coded jump leads with insulated handles, RED for the positive cable, BLACK for the negative cable.
 - (f) Check that the jump leads are in good condition without defects.

- **Connection steps – (i) for vehicles with *same* earth polarity**

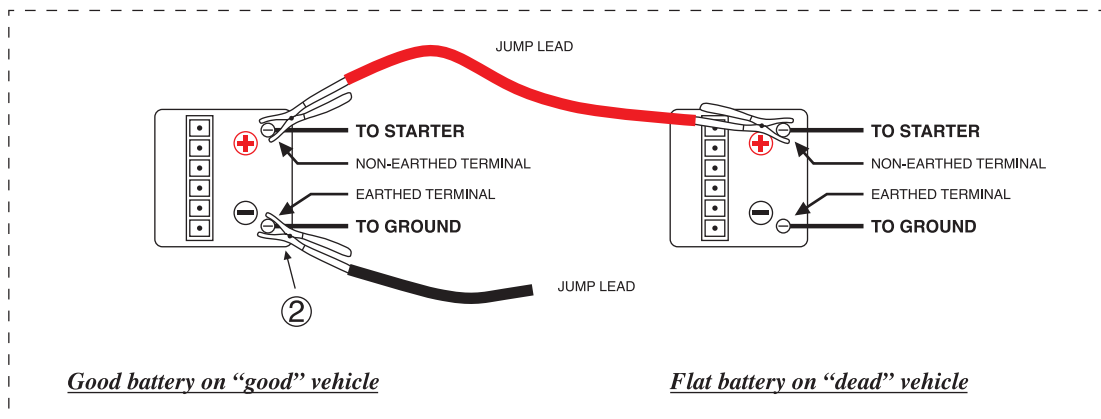
Step 1:

First connect the non-earthed terminal (+ve) of the good battery with the first lead (red) to the non-earthed terminal of the flat battery.



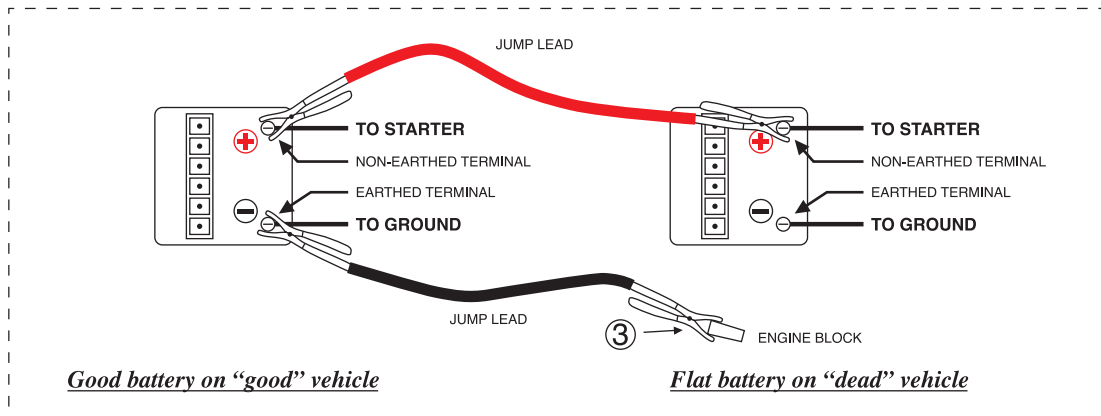
Step 2:

Connect one end of the second lead (black) to the earthed terminal (-ve) of the good battery.



Step 3:

Connect the other end of the second lead (black) to a suitable, substantial, unpainted point on the chassis or engine of the dead vehicle, away from the battery, carburettor, fuel lines or brake pipes.



- **Connection steps – (ii) for vehicles with *different* earth polarity**

WARNING: To avoid confusion that may cause danger, such connection should only be made by skilled and experienced personnel.

Step 1:

First connect the earthed terminal of the good battery with the first lead (red) to the non-earthed terminal of the flat battery.

Step 2:

Connect one end of the second lead (black) to the non-earthed terminal of the good battery.

Step 3:

Connect the other end of the second lead (black) to a suitable, substantial, unpainted point on the chassis or engine of the dead vehicle, away from the battery, carburettor, fuel lines or brake pipes.

- **Starting**

- (a) Make sure that the leads are well clear of revolving or moving parts.
- (b) Start the engine of the 'good' vehicle and allow to run for a few minutes.
- (c) Start the engine of the 'dead' vehicle and allow to run for a few minutes.

- **Disconnection steps**

- (a) Stop the engine of the good vehicle.
- (b) Disconnect the leads in the reverse order to which they were connected.
- (c) Take great care in handling jump leads. Do not allow the exposed cable terminals or other metal parts to touch each other or the vehicle body.

7. INFORMATION, INSTRUCTION AND TRAINING

7.1 Overview

- The proprietor should ensure that the workers should possess, by virtue of relevant training and experience, the competence that is commensurate with the assigned task. The training and experience should not only be relevant to the techniques of battery work but also the selection and safe use of proper equipment as well as other safety and health aspects of the work.
- The safety and health training should include general induction training and job specific training. It may be met by a mixture of on-the-job and off-the-job training and should involve demonstrations and practical exercises. It should embrace good trade practices, constituents of a safe workplace and information on the particular working conditions. When there are significant changes in the working environment, the proprietor should review the new situation and provide further information, instruction and training to workers to perform the task in the new working environment in a safe and healthy manner.
- Notwithstanding that the workers have been trained on the general safety and health aspects of battery work, the proprietor should provide appropriate specific information, instruction and training to the workers on the safety and health aspects that are commensurate with the assigned task.
- The proprietor should also keep the training records of the workers.
- The information, instruction and training should appropriately cover, but not limited to, the following:
 - (a) safety and health rules established in the workplace;
 - (b) safe working procedures for the assigned job task;
 - (c) proper selection and use of equipment and materials;
 - (d) proper selection and use of personal protective equipment and their limitations;
 - (e) emergency response procedures and evacuation plan; and
 - (f) specific safety and health considerations, such as work on exposed live battery cell terminals, manual handling of large battery set, use of chemicals, etc.

7.2 **General safety and health training**

- All persons involved in the battery work should be fully trained in the safety and health aspects of the work under normal operation as well as in emergencies. The general safety and health training should cover:
 - (a) hazards in battery work;
 - (b) relevant legislation and responsibilities of the persons concerned;
 - (c) equipment and safety devices for the work, including their uses and limitations;
 - (d) safety measures, including the selection and use of safety equipment and personal protective equipment, and their limitations;
 - (e) general safe practices for the work;
 - (f) emergency response and procedures including evacuation plan;
 - (g) general examination, and maintenance of equipment, equipment checks before and after use; and
 - (h) ways to build up good co-ordination and communication with other workers and arouse the awareness of taking care of other persons during their course of work.

7.3 **Task-specific safety and health training**

- In addition to the general safety and health training, task-specific training on the battery work should be provided. It is particularly important if the workers are to carry out work at workplaces that they are not familiar with. The training is to enable the workers to:
 - (a) understand clearly that particular work task, the works programme and the safe systems of work in place;
 - (b) understand and identify all potential hazards in the working environment and the necessary precautions to be taken; and
 - (c) identify factors affecting their individual capabilities in the work, etc.

8. EMERGENCY PREPAREDNESS

- 8.1 Emergency preparedness is vital for a safe system of work. Quick and correct response in case of emergencies is necessary to reduce injuries, harm and other damages. In this regard, the management should establish emergency response procedures for the workers to follow in case of emergency.
- 8.2 Emergency procedures are operating instructions which give guidance to workers as to when and how they should react in case of emergency. Appropriate procedures including the reporting mechanism in case of emergency, steps to control damages, evacuation from the workplace in extreme situations, and the re-enter procedures etc. should be established for each type of emergency situations and communicated to all workers.
- 8.3 A list of contact persons and emergency telephone numbers should be prepared, made known to all workers and be posted at conspicuous locations in the workplace.
- 8.4 Common emergency situations for the battery work include electric shock, battery explosion, fire, electrolyte spillage, personal injuries and illnesses, etc.
- 8.5 The management should also provide sufficient, appropriate and readily available emergency equipment and materials as stated in the emergency procedures. Emergency equipment would include, for example, fire extinguishers, emergency shower and eyewash bottles, first aid facilities, containment facilities, neutralizing agents for controlling electrolyte spillage, etc.
- 8.6 The workers should be given training on the emergency procedures and also on how to use the emergency equipment and materials properly. Hands-on practice should be given to the workers to ensure that they are acquainted with the use of the equipment and materials. Training records should be kept properly.
- 8.7 All the emergency equipment should be properly maintained and regularly inspected and tested as appropriate to ensure that they are kept in normal condition and ready for use. The related records should be properly maintained and expired items should be replaced immediately.

- 8.8 Locations of emergency equipment should be made known to all workers and be marked on plans of workplace and posted at conspicuous locations in the workplace.
- 8.9 The location of exits and evacuation paths in case of emergency should be made known to all workers and be marked on plans and posted at conspicuous locations in the workplace. Those exits and evacuation paths should always be kept clear and well lighted. Exit doors should not be locked.
- 8.10 Drills should be conducted periodically to ensure that all workers keep alert on and are well familiar with the emergency procedures.
- 8.11 The emergency procedures should be reviewed from time to time.

USEFUL INFORMATION

If you wish to enquire about this guidance notes or require advice on occupational safety and health, please contact the Occupational Safety and Health Branch of the Labour Department through:

Telephone : 2559 2297 (auto-recording after office hours)

Fax : 2915 1410

E-mail : enquiry@labour.gov.hk

Information on the services offered by the Labour Department and on major labour legislation can also be found by visiting our Home Page in the Internet. Address of our Home Page is <http://www.labour.gov.hk>.

Information on the services offered by the Occupational Safety and Health Council can also be obtained through hotline 2739 9000.