Guidelines for Recycling of Waste Batteries
(Lead Acid and Lithium-ion)

CENTRAL POLLUTION CONTROL BOARD

(Ministry of Environment, Forest and Climate Change)

Parivesh Bhawan, East Arjun Nagar

Delhi -110 032

website: www.cpcb.nic.in

(July 2026)

Table of Content

1.0 Background 2

2.0 Recycling of Waste Battery 2

2.1 Stakeholders involvement in Battery Recycling Ecosystem 2

2.2 Overall value chain of Battery Recycling 3

3.0 Waste Lead Acid Batteries Recycling 3

3.1 Facility required (indicative list), operating procedures for recycling of waste lead acid battery 4

3.2 Standards for emission / discharge for Lead 6

3.3 Steps to minimize fugitive emissions of Lead 6

4.0 Waste Lithium-ion Batteries Recycling 7

4.1 Facility required for Shredding and Hydro-metallurgical processing of Waste Lithium-ion Batteries (Indicative List) 7

4.2 Steps involved in Hydro-metallurgical processing of Waste Lithium-ion Batteries 10

4.3 Guidelines for dismantling of Waste Lithium-ion Batteries 11

4.4 Guidelines for Processing of Waste Battery for recovery of Metals/Metal Salts 11

4.5 Emission Standards 12

5.0 Records and Returns Filing 13

6.0 Actions in case of violations of Guidelines 13

Annexure – I 15

1.0 Background

Ministry of Environment, Forest and Climate Change, Govt. of India notified Battery Waste Management (BWM) Rules, 2022 on 22nd August, 2022 and amendments thereof. These regulations apply to producers (Manufacturers and Importers), dealers, consumers, and entities involved in the collection, segregation, transportation, refurbishment, and recycling of all types of waste batteries, regardless of their chemistry, shape, volume, weight, material composition, or use. Battery types covered include portable, automotive, industrial, and EV batteries, encompassing various chemistries such as lead acid, lithium-ion, nickel-cadmium, zinc-based batteries etc.

As per provision under Rule 11 (17) the BWM Rules, 2022, "*Central Pollution Control Board shall issue guidelines for environmentally sound procedures of collection, storage, transportation, refurbishment, and recycling of Waste Battery.*"

In view of above, guidelines have been prepared and elaborated in the following sections for environmentally sound management and recycling of Waste Battery in accordance with the BMW Rules, 2022.

2.0 Recycling of Waste Battery

Battery recycling is vital for environmental sustainability and conserving resources. By reclaiming materials like lithium, cobalt, nickel, lead etc. from used batteries, recycling reduces virgin/primary raw material demand and minimizes hazardous waste impacts. In India, battery recycling is governed by the Battery Waste Management Rules, 2022, which mandate environmentally sound management, traceability through the EPR portal, and scientific recycling processes. These guidelines provide approach to ensure safe collection, storage, transport, dismantling, resource recovery, and disposal of waste batteries in compliance with the Battery Waste Management Rules, 2022.

2.1 Stakeholders involvement in Battery Recycling Ecosystem

The battery recycling ecosystem involves various stakeholders, including consumers, dealers, producers, battery collection centres, refurbishing units, and recycling facilities. This system manages the movement of batteries from end-users to recycling units through regulated pathways. A robust battery recycling framework can lead to increased collection rates of waste batteries and improved recovery of critical minerals from used batteries.

2.2 Overall value chain of Battery Recycling

The battery recycling value chain commences with the establishment of a recycling facility equipped with appropriate infrastructure, technology, and safety protocols to manage various battery chemistries. The process begins with the collection of end-of-life batteries from designated collection points, consumers, and authorized dealers, producers etc. These batteries are then transported to the recycling facility in accordance with regulatory guidelines to ensure the prevention of environmental contamination and safety hazards. Upon arrival, the batteries are stored in secure, compliant conditions to mitigate risks associated with leakage, fire, or chemical exposure.

Following storage, the batteries undergo sorting based on type, size, and chemical composition to ensure proper downstream processing. A detail inspection is conducted to identify and segregate Waste batteries or batteries that can be refurbished for second use. Subsequent handling procedures adhere to safety standards to prevent accidental discharge or exposure to toxic substances. The waste batteries are then dismantled into their constituent components, such as electrodes, casings, and electrolytes. Finally, these materials are subjected to processing for the recovery of valuable metals facilitating resource efficiency and contributing to the circular economy.

The overall value chain of Battery Recycling is shown below:

📌 Setting up of Recycling Facility → 📥 Collection → 🚚 Transportation → 🛠 Handling → ⚡ Discharging / Acid Draining → 🛍 Storage → 🔄 Sorting → 🔍 Inspecting → 🔧 Dismantling → 🏭 Processing for Recovery of Metals / Metal Salts.

3.0 Waste Lead Acid Batteries Recycling

The lead acid Battery recycling process begins with the dismantling, where used lead-acid batteries are cut open using a battery-cutting machine / manual dismantling. The extracted plastic parts are sent to a plastic recycler, the lead-bearing materials are separated for further processing, the electrolyte (sulphuric acid) is drained from the batteries is either neutralized and treated in ETP. The lead components are then fed into a furnace in the lead smelting section, where they are smelted using additives like charcoal, soda ash, iron chips, and flux. This process results in the formation of re-melted lead, which is collected for refining.

The re-melted lead is transferred to the Refining Alloying Kettle, where impurities are removed, and lead alloys are created as per industrial requirements. The refined lead is then processed into lead ingots using an ingot casting machine. Suitable Pollution control equipment, such as dust collectors, cyclones, bag houses, wet scrubber, stack etc., should be installed to ensures that emissions and environmental impact are minimized during the process.

3.1 Facility required (indicative list), operating procedures for recycling of waste lead acid battery

- Type of furnace (Rotary/Mandir Bhatti/Refining Alloy kettle)

  a. Rotary furnace with suction hood connected with adequate Air Pollution Control System (APCS) over the charging point exists

  b. Mandir Bhatti with suction hood connected with adequate APCS over the charging point and molten metal tapping point**.**

  c. Refining Kettle with suction hood connected with adequate APCS over the charging point.

- Furnace connected with expansion chamber, cooling tubes/ducts, Cyclone/ Multi Cyclone, Bag filter with pulse jet/ mechanical shaker arrangement, Alkaline Scrubber with arrangement of alkali dosing, & connected with ETP, ID fan and stack of minimum 30-meter height.

- Each stack should have minimum stack height of 30 meter and a port- hole (as per the guidelines on methodologies for source emission monitoring published by CPCB under Laboratory Analysis Techniques LATS/80/2013-14) with platform for stack monitoring. There should be an easy ladder (Spiral Type / Scaffold ladder / Zig-Zag Ladder) for safe access to stack monitoring platform.

- Battery-Breaking Processes: After draining the acid there are two modes of braking of batteries before battery plates are processed for smelting. The first mode is manual where the battery is cut from top, plates are removed and left over acid is drained. The second mode is where the battery is mechanically broken along with casing

- The facilities required for manual dismantling include suction hood, connected to adequate pollution control device, arrangement for washing of plastic components before being sent for recycling and acidic water neutralization facility. All the facilities with capacity more than 5000 MTA should install mechanical / automated waste battery breaking system within one year from the date of notification of the guidelines. Smaller Units (< 5,000 MTA) should install mechanical / automated waste battery breaking system within three years from the date of issue of the guidelines.

- Cutting operation through mechanical / automated system should be conducted on the concrete floor within shed structure.

- Charging of the furnace may be mechanized using system such as vibro-feeders / silo-fed systems / scoop attachments mounted on forklifts etc. which reduces worker's exposure to lead fumes and dust and eliminates manual handling

- The unit should have separate covered storage space, having impervious acid proof flooring with acid collection tank connected with neutralization tank, for storage of used/waste lead acid battery. The acid collection tank should have arrangements for control of acid fumes such as fume arrester connected with adequate APCS.

- The Unit should have Effluent Treatment Plant(ETP) to treat waste water from battery-breaking system. The ETP should be based on physio-chemical treatment of waste water and should have provision for acid neutralization. After neutralizing the acid, for its disposal the unit should follow the consent conditions. The acidic effluent from floor washing should be channelized into the neutralization tank.

- The mechanical / automated battery breaking system will have arrangement for noise control in the form of acoustic enclosure, dust and fume extraction system, acid collection and neutralization facilities and ETP for treatment of lead and acidic waste water.

- The unit should have adequate facilities for the collection and storage of ETP sludge. The sludge from the ETP plant should be stored in a covered sludge storage facility as per the hazardous & other wastes (management and transboundary movement) rules, 2016 as amended and guideline and send to TSDF.

- Unit should have separate, secured and covered space with concrete floors for storage of residue and slag generated from recycling of lead scrap/used lead acid batteries and maintain records of transfer of hazardous waste to TSDF.

- All APCS should be installed on concrete flooring to prevent contamination of soil and groundwater.

- Plastic boxes / chips generated during battery dismantling contains lead contamination. Therefore, these plastic boxes / chips may should be properly treated and sent to registered plastic processors / recyclers or may be treated in-house using suitable plastic processing system.

- The pallets packaging material should be disposed only to TSDF.

- Units shall provide proper PPEs such as gloves, masks, boots, aprons etc. to the workers.

3.2 Standards for emission / discharge for Lead

- Lead in work area, NIOSH 8-hr avg. (mg/m^3): 0.05
- Lead in emissions through stack (mg/Nm^3- normal cubic meter): 10.0
- Lead in effluents (mg/l): 0.10
- Lead in factory premises near boundary wall 24-hr avg. ($\mu g/m^3$): 1.0
- Worker's blood lead levels: As a practice, all lead related Units should periodically examine their workers at least once in year for lead level in blood as well as urine. Persons with higher lead levels (greater than 42 (µg/dl) should be shifted immediately to non-lead activity areas and given special medical treatment ill the lead levels come back to acceptable level (10 µg/dl)

  Note: Recyclers should also comply with the standard prescribed under E(P) Rules, 1986 for other parameters.

3.3 Steps to minimize fugitive emissions of Lead

- The design of hood /fume collection system from the smelting / refining operations (from lead metal emissions tapping point, charging doors, furnace joints etc.) should be capable of collecting and transfer to the Air Pollution Control System (APCS)
- The storage and handling of all the raw materials, intermediates and products should be used in covered area/ shed having concrete floors and mechanized equipment should be there to handle these materials as far as possible
- The floors in the loading area should be kept wet through sprinklers to reduce the chances of lead particles/ dust getting airborne
- Any water used for washing, rain water etc., should be collected through separate pits (to delink this from the regular drain) for removing metallic lead etc. and the pit should have fine screens for passage of clear water.
- The movement of vehicles to the administrative /working /production areas should ensure that only the trucks /vehicles involved in the material handling/ transportation reach the work areas, and their tyres are washed before they leave these areas;

- The unit should have facilities for washing tyres of vehicle entering and going out of the recycling facility. Waste water from the tyre washing area should be send to ETP for treatment.

4.0 Waste Lithium-ion Batteries Recycling

The lithium-ion battery recycling process typically begins with discharging the waste batteries, commonly by submerging them in a salt solution to neutralize any residual charge. However, this is not the only method—other appropriate technologies may be used to discharge the waste batteries. After this, the batteries undergo crushing and shredding to break them down into smaller components. The resultant materials include a mixture of copper (Cu), aluminium (Al), and iron (Fe), along with black mass containing valuable metals. A magnetic separator is used to extract iron from the mixture, leaving behind copper and aluminium. These non-magnetic materials are then subjected to a density separator, which further separates copper and aluminium based on their different densities.

The black mass undergoes advanced metallurgical processing to recover valuable metals and metal salts such as lithium, cobalt, and nickel etc. This can be achieved through pyro-metallurgical, hydrometallurgical, and electrochemical processes. Currently, hydrometallurgical process is being deployed for metal recovery from black mass in India. This method involves treating the black mass with chemical solutions to dissolve and extract metal salts. The pyro-metallurgical process, on the other hand, uses high-temperature treatment to break down battery materials and separate valuable components. Soluble lithium is then recovered through water-based extraction, followed by filtration and evaporation to obtain purified lithium compounds.

4.1 Facility required for Shredding -and Hydro-metallurgical processing of Waste Lithium-ion Batteries (Indicative List)

S. No.	Type of Recyclers (R2 / R3 / R4) as categorized under Battery Waste Management Rules, 2022	Particulars
1.	R2 , R4	Dedicated storage area for storage of different types of Lithium-ion batteries.

2.	R2, R3, R4	Storage and utilization area should be equipped with proper firefighting equipment and fire hydrant system with sprinklers system and foam type extinguishers to avoid the fire hazard.
3.	R2, R4	Tank for discharging of waste lithium-ion batteries in salt solution or other suitable Equipment's for discharging process
4.	R2, R4	A drying unit and conveyor system may be used to transport discharged batteries to the shredder or crusher. For large batteries or cells, transportation may be carried out using other suitable mechanical means if the use of a conveyor system is not feasible.
5.	R2, R4	Shredding / Crushing unit.
6.	R2, R4	The Shredding/ Crushing unit should use flame proof electrical fitting and should be adequately safe. The parts should be guarded to prevent any physical injuries.
7.	R2, R4	The feed rate may be auto-controlled through hoppers and conveying mechanism to avoid over feeding. Temperature control should be installed in shredding unit and drying unit.
8.	R2, R4	System shall be in place at shredding unit to collect electrolytes or incise electrolytes, to avoid fugitive emission at work place. Collected electrolytes may be sent for incineration / co-processing / recycling for recovery of materials.
9.	R2, R4	Magnetic and / or density separator of separating unit for separating Fe, Cu, Al, plastic from black mass
10.	R2, R4	Suitable Pollution Control Device (like Suction Hood, Cyclone, pulse jet Bag filters, etc.) for capturing dispersed black mass during the separation of Fe, Cu, Al, plastic, and black mass.
11.	R2, R3, R4	Dedicated storage area for storage of black mass bags or containers; solvents/ acids storage tanks with proper cover, acid proof brick lining, proper slope and collection pit with caution sign under cool, dry, well-ventilated covered sheds shall have proper slope and seepage collection pit to collect seepage / floor washing.

12.	R2, R3, R4	Mechanised systems – for loading, unloading, storage, transfer and other handling of black mass in entire utilization process.
13.	R3, R4	An alkaline scrubbing system to the reactors (leaching and extraction units) or reactors and vessels may be fitted with lids.
14.	R3, R4	Bag filters at the salt crushing process (Optional - as some of the crushing unit may not require dust collector due to wet condition of salt. Salts may also be sold without crushing).
15.	R3, R4	Suitable Pollution Control Devices (like Fume extraction system followed by activated carbon filter) in the solvent extraction unit area connected to stack.
16.	R3, R4	Wastewater generated from the process, floor washing, spillage, reactor washing, scrubber bleed, condensate from MEE etc. may be reused in the process or to be treated physio chemically in an ETP to comply with wastewater discharge standards as prescribed by SPCB/PCC.
17.	R3, R4	Leaching reactors
18.	R3, R4	Filtration units
19.	R3, R4	Extraction reactors
20.	R3, R4	Stripping units
21.	R3, R4	Centrifuge or any alternate drying equipment
22.	R3, R4	Crystallization units (Optional)
23.	R3, R4	Evaporation/ drying units
24.	R2, R3, R4	Stack with spiral / scaffold / zig-zag type ladder- to have sampling port, platform, access to the platform etc. as per the guidelines on methodologies for source emission monitoring published by CPCB under Laboratory Analysis Techniques LATS/80/2013-14. The air pollution control systems (fume scrubbers and bag dust collectors etc.) shall be connected to stack of height 30m or more as may be prescribed by SPCBs/PCCs).
25.	R2, R3, R4	Online analysers - for PM, HF, and TOC in the stack in case of continuous process operations.

Note: *(i) R2: Only Battery Dismantling and Physical separation (Processing till Black Mass Generation) of all types of battery except Lead acid battery*

(ii) R3: Refiners – Only Black Mass Processor (Processing till metals are obtained in compound form) of all types of battery except Lead acid battery

(iii) R4: Battery Dismantling, Physical Separation and Refining (Black Mass Processing) of all types of battery except Lead acid battery

4.2 Steps involved in Hydro-metallurgical processing of Waste Lithium-ion Batteries

The recycling process begins with sorting, discharging, and dismantling large-size batteries. To facilitate handling, batteries can be broken down into smaller cells or module levels. During dismantling, external materials such as steel or aluminium casing, plastics, electronics, and cables are separated. Since some batteries may still hold a charge, precautions are necessary and it should be discharged before further processing. Given that lithium-ion batteries (LIBs) pose fire and safety risks due to mechanical damage, inflammable components, volatile compounds, or thermal runaway characteristics, they may need to be fully discharged before further processing.

After dismantling and discharging, waste batteries are transported via a conveyor belt or forklifts / trolleys to a shredding or crushing unit. This process produces a mixture of aluminium (Al), iron (Fe), copper (Cu), plastics, and black mass. The black mass, which contains valuable materials aluminium (Al), iron (Fe), copper (Cu), is separated from the mixture using magnetic and/or gravity-based separation techniques. The separated black mass is then prepared for further chemical processing to recover critical metals.

The black mass, along with reagents (Acid, Water, etc.), is fed into a reactor under controlled pH and temperature conditions. The leachate is separated from the solid residue through filtration, forming a residue known as a cake. This cake is washed with water and collected as graphite. The filtered leach liquor undergoes further purification to separate impurities.

The filtrate from the purification unit is processed through a solvent extraction circuit to sequentially recover manganese, cobalt, nickel, and lithium using organic extracting solvents. These metals are stripped separately with sulphuric acid, followed by precipitation with reagents, yielding metal salts (such as manganese sulphate/carbonate, cobalt sulphate/carbonate, nickel sulphate/carbonate, lithium sulphate/carbonate). The remaining raffinate primarily contains sodium sulphate, which undergoes further processing in a multiple-effect evaporator (MEE) to produce sodium sulphate crystals, while the condensate water is recycled back into the process for leaching and washing purposes.

4.3 Guidelines for dismantling of Waste Lithium-ion Batteries

- Before initiating the dismantling process, battery packs should be fully discharged to safe limit. This is typically done using static or dynamic resistance through an electronic load or through alkaline solution.

- To access the battery modules, various components such as the protective casing, power electronics, Battery Management System (BMS), and system covers may be removed.

- Voltage measurements should be conducted before or during the dismantling process to ensure safety and proper handling.

- Temperature measurements may be performed using a heat scan to detect any anomalies.

- Battery cells exhibiting temperature deviations from the ambient environment may be stored in a secured area after measuring their residual charge. These cells should be continuously monitored (may be kept inside salt water to retain temperature and ensure safety).

- All safety precautions and measures should be taken during dismantling process to prevent any health or fire hazard. Adequate fire protection system should be installed and regularly checked.

4.4 Guidelines for Processing of Waste Battery for recovery of Metals/Metal Salts

- Separation of black mass from metals such as Al, Fe, Cu, etc. shall be carried out in a covered area to avoid fugitive emission of black mass. Adequate APCS such multi-cyclone, pulse jet bag filers etc. with suction system should be installed during handling and processing.

- The unit shall provide a suction hood connected to a bag filter system to control fugitive emissions during the charging of black mass (particulate matter) into the reactor.

- The unit shall provide an alkaline scrubbing system to control acidic fumes emitted from the reactors (leaching and extraction units).

- The unit shall provide APCS to control metallic salt dust generated from the salt crushing process.

- The unit shall provide fume extractions system followed by activated carbon filter to control VOC fumes in the solvent extraction unit area.

- The unit shall maintain proper ventilation in the work zone and process areas. All personnel involved in the plant operation shall wear proper personal protective equipment (PPE) specific to the process operations involved and type of chemicals handled as per Material Safety Data Sheet

(MSDS). The safety precautions of the worker shall be in accordance with the Factory Act, 1948, as amended from time to time.

- In case of environmental damages arising due to improper handling including accidental spillage during generation, storage, processing, transportation and disposal, the occupier (sender or receiver, as the case may be) shall be liable to implement immediate response measures, environmental site assessment and remediation of contaminated soil / groundwater / sediment etc. as per the "Guidelines on Implementing Liabilities for Environmental Damages due to Handling & Disposal of Hazardous Wastes and Penalty" published by CPCB.

- The unit shall provide suitable fire safety arrangements and flame proof electrical fittings.

- All safety precautions and measures should be taken during processing to prevent any health or fire hazard. Adequate fire protection system should be installed and regularly checked.

4.5 Emission Standards

- Source emissions from the stack connected to reactors/ process unit shall comply with the following emission standards or as prescribed by the concerned SPCB/PCC, whichever is stringent:

Particulate Matter	50 mg/Nm^3 *(Ref: Dry Cell Manufacturing Industry: Emission Standard, EPA)*
Manganese as Mn	5 mg/Nm^3 *(Ref: Dry Cell Manufacturing Industry: Emission Standard, EPA)*
Sulphuric acid mist	50 mg/Nm^3 *(Ref: General Emission Standards, EPA)*
Total Fluoride	25 mg/Nm^3 *(Ref: General Emission Standards, EPA)*
Hydrogen Fluoride	4 mg/Nm^3 *(Ref: Common Hazardous Waste Incinerator Emission Standards, EPA)*
TOC	20 mg/Nm^3

- Work zone emission in the work zone area shall comply with the following standards:

PM10	5 mg/m^3 TWA* (PEL)
Sulphuric acid	1 mg/m^3 TWA* (PEL)
Hydrogen Fluoride	3 ppm TWA* (PEL)

Fluorides (as F)	2.5 mg/m^3 TWA* (PEL)
Manganese compounds (as Mn)	5 mg/m^3 **
Cobalt metal, dust, and fume (as Co)	0.1 mg/m^3 TWA* (PEL)
Copper Dusts and mists (as Cu)	1 mg/m^3 TWA* (PEL)
Nickel	1 mg/m^3 TWA* (PEL)

*PEL - Permissible Exposure Limit.

*Time-weighted average (TWA) - measured over a period of 8 hours of operation of process.

** A ceiling limit is one that may not be exceeded for any period of time and is applied to irritants and other materials that have immediate effects.

- Monitoring of the above specified parameters for source emissions and work zone emission shall be carried out quarterly for first year followed by at least annually in the subsequent year of utilization. The monitoring shall be carried out by ISO 17025 accredited or EPA, 1986 approved laboratories and the results shall be submitted to the concerned SPCB/PCC as per CTO granted by SPCB.
- Standard for wastewater discharge: Treated effluent shall be discharged in accordance with the conditions stipulated in Consent to Operate issued by concerned SPCB/PCC under the Water (Prevention and Control of Pollution) Act, 1974.

5.0 Records and Returns Filing

- Recyclers have to register on the online EPR portal for Battery Waste Management developed by CPCB.
- As mandated under the Battery Waste Management Rules, 2022, recyclers shall generate and transfer EPR certificates to the producers for fulfilment of their EPR target through the online EPR portal.
- Recyclers shall provide Financial Year-wise waste battery procurement data, recycled battery data, and sales data of the recovered material sold on the Online EPR Portal.
- Recyclers shall generate EPR certificates and transfer the EPR certificates to producers for fulfilment of their EPR targets.
- Recyclers shall submit quarterly returns through the online EPR portal.

6.0 Actions in case of violations of Guidelines

Action against violations of these Guidelines will be taken in accordance with the Guidelines for Environment Compensation (EC) under the Battery Waste Management Rules, 2022, published in September 2024.

Note: These guidelines will be applicable in addition to:

(i) *Guidelines for Utilization of Black mass (generated by Lithium Ion Batteries dismantlers/recyclers or e-waste dismantlers/recyclers) for the recovery of Carbon/Graphite material and Metal compounds (Sulphates, Carbonates, Phosphates of Co, Mn, Ni, Li, Cu, Fe, Al & Na) by adopting Hydro-Metallurgy published in January, 2025.*

(ii) *Standard Operating Procedure(SOP) for Recycling of Lead Scrap/ Used Lead Acid Batteries published in January, 2024.*

--xx--

Annexure – I

Lithium-ion battery Hydrometallurgical recycling process