OES 2026-04 November 2026

Understanding the Risks & Safe Handling of Damaged, Defective, or Recalled (DDR) Batteries

Purpose

This Operating Experience Summary (OES) provides the U.S. Department of Energy (DOE) with information on the risks and safe handling of Damaged, Defective, or Recalled (DDR) batteries. DDR batteries pose significant safety risks from overheating, fire, explosion, and the release of hazardous substances. The number of fire-related events associated with improperly managed batteries continues to rise. Certain battery chemistries, particularly lithium batteries, may also experience thermal runaway[1], which can result in rapid heat generation, venting of gases and electrolytes, smoke, or fire, making their proper handling and disposal crucial. DDR battery hazards pose a significant danger to DOE's operating facilities, personnel, storage areas, shipping operations, and waste handling facilities.

Key topics addressed in this OES include:

- Raising awareness of the hazards
- Identifying and controlling the hazards
- Safely handling, storing, and preparing DDR batteries for authorized shipment
- Implementing prevention and mitigation strategies
- Establishing emergency response processes
- Identifying available resources



Figure 1: Photo of batteries that caught fire. Photo courtesy of Underwriters Laboratories (UL) Fire Safety Research Institute (2026).

Applicability & Disclaimer

Notice: The guidance, metrics, and recommendations contained within this OES apply exclusively to commercial off-the-shelf (COTS) and commercially sourced batteries.

Exclusion: This OES does not apply to custom, specialized, or mission-specific battery assemblies. Specialized batteries often require unique technical requirements, specific operational procedures, and dedicated safety handling instructions that may differ from standard commercial practices.

Purpose of Exclusion: This distinction helps prevent conflicting requirements, supports operational safety, and preserves the integrity of specialized battery protocols. Users handling non-commercial or custom battery systems should refer to their specific facility procedures, manufacturer specifications, or technical authority directives.

[1] Thermal runaway is an uncontrollable, self-heating state of a lithium-ion cell accompanied by gas, electrolyte venting, smoke, or fire—or a combination of all. [Source: What Is Thermal Runaway? - Underwriters Laboratories Research Institutes]

Background

Although the odds of a battery exploding or catching fire are low, estimated to be between 0.00005% and 0.004% per battery[2], the risks increase with DDR batteries. Damage, manufacturing defects, overcharging, exposure to excessive heat, and other conditions can cause battery failures that may initiate thermal runaway.

Potential hazards of DDR batteries include overheating, fire, electrical shock from battery chargers, thermal burns, exposure to battery electrolytes, explosion, exposure to hazardous gases, and the high-velocity ejection of internal battery components. Reports[3] indicate incidents have occurred while the product is in use, in storage, and during battery charging. For transportation, the U.S. Department of Transportation (DOT), through the Pipeline and Hazardous Materials Safety Administration (PHMSA), regulates lithium batteries as hazardous materials. DDR lithium batteries are subject to more stringent handling, packaging, and transportation requirements. Failure to identify and properly handle DDR batteries can create additional risks during transportation and potentially endanger workers and communities.

Operational History

Although much of the following data comes from non-DOE sectors, the underlying battery failure mechanisms and consequences are directly relevant to DOE activities. Organizations use, charge, store, handle, ship, and discard commercially sourced batteries in a variety of operating environments. A DDR or improperly discarded battery can injure personnel, damage facilities and equipment, disrupt waste-management and transportation activities, require an emergency response, and delay mission work. This OES presents these external events as operating experience to help DOE organizations identify comparable hazards and strengthen local prevention, segregation, storage, transportation, and emergency response controls. Current data indicates an increase in DDR battery-related events across multiple industries and government agencies, including DOE.

Waste and Recycling Facility Fires:

- **Rising Trends:** Publicly reported fires at U.S. and Canadian recycling or material recovery facilities (MRFs) rose 15% from 2023 to 2024. In 2025, reported fires increased by a record 25%, and 2026 is on track to match that level.[4]
- **Leading Causes:** Battery-related fires in waste and recycling facilities are increasing across the U.S. and Canada. While more than 300 incidents are formally reported at facilities during normal operations each year, estimates suggest over 5,000 fires actually occurred due to improper waste disposal. Lithium batteries discarded in curbside bins are a leading cause; when crushed during compaction and processing, these batteries ignite, triggering severe property damage, prolonged operational shutdowns, and hazardous emissions.[5]
- **High-Risk Areas:** Most fires originate in tipping floor areas, where waste is first dumped.
- **Impact:** In addition to damaging infrastructure, these fires can create significant environmental risks by emitting hazardous fumes and particulate matter.
- **Waste Industry:** Industry losses were estimated at $2.5 billion in 2025.[6]

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[2] Pipeline and Hazardous Materials Safety Administration (PHMSA) – Understanding the Risks of Damaged, Defective, or Recalled (DDR) Lithium Batteries
[3] https://batteryrecyclingandsolutions.com/blog/ddr-battery-guide/
[4] Jan Fire Report: National Waste & Recycling Association (NWRA), Recycled Materials Association (ReMA), and Solid Waste Association of North America (SWANA) Publish Battery Fire Guide – Waste 360
[5] NWRA and Resource Recycling Systems (RRS) Release Report on Threat of Lithium Batteries to Waste and Recycling Infrastructure
[6] Waste Industry Still Battling Battery Fires as Losses Estimate $2.5 Billion – Waste 360

Aviation:

- The Federal Aviation Administration (FAA) reports 794 verified lithium battery incidents between March 3, 2006, and September 15, 2026[7].
- Most incidents involve battery packs in passenger compartments or cargo holds.
- FAA 2024: 90 verified incidents (78 on passenger aircraft, 12 on cargo carriers).
- FAA 2025: 97 verified incidents (82 on passenger aircraft, 15 on cargo carriers).
- Annual totals were significantly lower in earlier years, with historical tracking showing totals increasing by more than 388% since 2015 due to the proliferation of portable electronics[8].

Residential/Industrial:

- The National Institute of Standards and Technology (NIST) estimates roughly 198,000 lithium battery structure fires in the U.S. since 2011.
- According to the U.S. Consumer Product Safety Commission (CPSC), between 2017 and 2022, at least 25,000 incidents of lithium batteries overheating or catching fire were reported in the U.S., resulting in approximately 141 injuries and 13 deaths[9].

DOE-Related Reports:

Between June 2020 and June 2026, there were 33 battery-related events reported within DOE, as detailed in Figure 2.

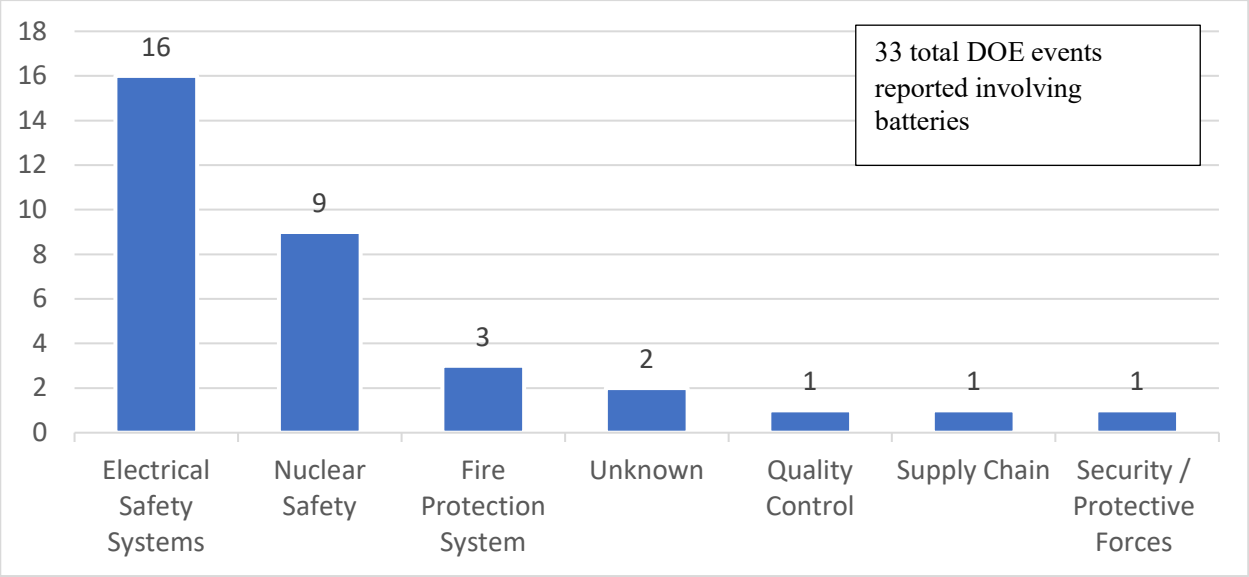

Figure 2: DOE events by system type.

[7] https://www.faa.gov/hazmat/resources/lithium_batteries/incidents
[8] Nearly two lithium battery fires per week on airplanes in the U.S. alone - Comité Technique International de prevention et d'extinction de Feu - CTIF.org
[9] Lithium-ion battery fires: myth vs. reality–Technischer Überwachungsverein/Technical Inspection Association, - TUV SUD

Identification and General Mitigation of DDR Batteries

The following are key indicators that can help determine whether a battery is DDR. Recognizing these indicators is critical so that battery users, material handlers, and personnel responsible for battery disposal do not overlook signs of a DDR battery.

- **Known defective or recalled batteries**: Check for manufacturer recalls or defect notices. You can typically find these through resources such as the Consumer Product Safety Commission (CPSC) or directly on the manufacturer's website. Additional resources are available in the References & Resources section of this OES.
- **Leaked or vented batteries**: Visible signs of electrolyte leakage, residue, or venting.
- **Hissing sounds:** Hissing, popping, or other unusual sounds may indicate gas venting, internal failure, or another potentially hazardous condition.
- **Physical or mechanical damage**: Swelling or deformation of the battery or casing that may be due to internal pressure buildup.
- **Discoloration**: Unusual discoloration, scorching, melting, or other evidence that the battery has been exposed to or generated excessive heat.
- **Odor or corrosion**: Unusual odors, residue, or signs of corrosion.
- **Loose or damaged wires**: Any compromised connections (e.g., frayed or loose wires, exposed terminals, or damaged connections).
- **Known or observed misuse or mishandling**: Batteries exposed to extreme conditions, misuse, or mishandling.
- **Battery is warm when not in use**: This may indicate an internal fault or short.
- **Suspected damage:** If damage is suspected but cannot be confirmed, treat the battery with caution.

Prevention and Mitigation Practices Applicable to DOE Operations:

DOE organizations may consider the following industry practices and apply them based on site-specific activities, hazards, and existing procedures:

- **Battery Awareness and Disposal Controls:** Ensure personnel know how to recognize DDR batteries and understand that these types of batteries should not be placed in routine trash or recycling. Provide clear instructions for reporting, segregating, and transferring these batteries to the appropriate site organization or qualified disposal provider.
- **Risk-Based Detection and Monitoring:** Consider infrared cameras, thermal monitoring, or other suitable detection methods in higher-risk locations where batteries are charged, stored, accumulated, or handled. Early identification of abnormal heat may help prevent escalation and support a timely emergency response.
- **Operational Training:** Train personnel whose duties involve battery-powered equipment, material handling, waste operations, storage, transportation, or emergency response to recognize smoking, overheating, or otherwise suspect materials and follow applicable isolation, notification, and emergency procedures.
- **Battery Collection and Management Programs:** Establish clearly identified collection pathways and organizational responsibilities for DDR batteries for segregation from routine waste and management in accordance with applicable site procedures and transportation requirements.

General Safety Precautions:

- **Isolation:** If it can be done safely, move the damaged unit to an isolated, fire-safe area (e.g., outdoors or on a concrete surface).
- **Prevent Shorts:** When safe, tape exposed terminals with electrical tape to prevent short circuits.
- **Personal Protective Equipment (PPE):** Wear safety glasses and chemical-resistant gloves when handling damaged batteries.

Handling & Storage of DDR Batteries

Handling and storing DDR batteries require extreme care. Personnel should not discard DDR batteries in regular trash or recycling bins because they can leak hazardous chemicals, vent flammable gases, pose environmental hazards, and cause fires in storage containers, waste collection facilities, or during transportation.

The following recommendations can help personnel store and handle DDR batteries safely:

- **DDR kits**: Use a kit specifically designed to safely store and ship damaged batteries.
- **Use specialized containers**: Place the battery in a non-metallic, fire-resistant container.
- **Wear gloves**: Always wear gloves to avoid direct skin contact with damaged batteries.
- **Use sand or non-flammable silica material**: Store the battery in a non-combustible container filled with sand or non-flammable silica material to stabilize it. The Underwriters Laboratories (UL) Fire Safety Research Institute indicates that Oil Dri[10] is better suited for electrolyte leakage, whereas sand and similar materials are more suitable for thermal management.
- **Avoid metal**: Keep batteries away from metal objects. If multiple batteries are to be placed in one container, consider taping the leads or placing them inside a plastic bag to prevent shorting the battery terminals. Separate multiple batteries with a layer of sand or non-flammable silica material.
- **Cool, dry place**: Store in a cool, dry environment clear of other combustible materials. Storage in an exterior location is highly recommended.
- **Separation**: Keep containers separated from other materials, ideally in a dry storage area.
- **Do not recycle**: Never place DDR batteries in regular garbage or recycling bins.
- **Venting**: Always store DDR batteries in properly vented containers to prevent hazardous gas buildup and minimize fire or explosion risks. If a certified vented container is unavailable, leaving the container lid loose (i.e., without tightening the securing band) can serve as a temporary alternative.
    - ***Note***: While venting is the safest storage practice, carrier acceptance of vented containers varies as regulations evolve. Coordinate with the carrier beforehand, as shipping vented containers may require special permits or specific carrier approval.

Shipping Guidance for DDR Batteries

Shipping damaged lithium batteries requires compliance with applicable U.S. Department of Transportation (DOT) requirements. The Lithium Battery Guide for Shippers[11], provided by PHMSA and based on the Hazardous Materials Regulations, is a tool that provides information on applicable requirements, including packaging, marking, labeling, and transportation restrictions.

Transportation and Disposition Considerations for DDR Lithium Batteries:

DDR lithium batteries may require off-site transportation for manufacturer return, recycling, or disposal. Because their condition may create additional hazards during transportation, personnel should not independently prepare, package, mark, label, or offer a DDR lithium battery for shipment. Personnel should contact their site's designated hazardous materials transportation/shipping and waste management organizations to evaluate the battery and determine the appropriate disposition and transportation pathway.

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[10] Oil-Dri granular absorbent is a mineral-based clay or attapulgite/bentonite product used temporarily as a general-purpose dry packing or cushioning material when storing, handling, or transporting DDR batteries.

[11] Lithium Battery Guide for Shippers (October 2024). U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration (PHMSA).

The U.S. DOT regulates the transportation of lithium cells and batteries under its Hazardous Materials Regulations, including Title 49 of the Code of Federal Regulations (49 CFR) § 173.185. Additional requirements apply under § 173.185(f) to DDR lithium batteries that have the potential to produce a dangerous evolution of heat, fire, or short circuit. [12] The site or organization responsible should determine whether these requirements apply and identify the appropriate packaging, marking, labeling, mode of transportation, and carrier coordination. This OES provides general awareness and does not restate the regulatory requirements, replace site procedures, or establish additional shipping requirements.

Personnel should coordinate recycling or disposal separately through the site's waste management organization and approved service providers. Commercial shipping kits or vendor programs should be used only when authorized by the responsible site organization and when consistent with applicable regulatory and site requirements.

Recommended Emergency Procedures

- Evacuate the immediate area and follow the facility/site Emergency Response Plan or similar plan, including calling 911 when required.
- Alert others nearby to stay clear.
- Do not touch or try to move, smother, or bury a burning battery. Keep people away from the hazardous fumes and smoke emitted by the battery.
- If the fire involves a lithium battery, trained, equipped, and authorized personnel may use water to cool the cells when consistent with the site-specific Emergency Response Plan.
    - Note: Do not attempt firefighting operations unless you are properly trained, equipped, and authorized. In the event of a fire, immediately consult and execute the site-specific Emergency Response Plan or similar plan.
- Remain upwind at least 100 feet from the location, if possible.
- For lithium battery fires, large quantities of water are commonly used to cool the batteries and help control thermal runaway.
    - Note: A lithium battery in thermal runaway requires cooling; most portable fire extinguishers, including Class D extinguishers, do not stop thermal runaway.
- Be aware of re-ignition. Even after flames appear extinguished, damaged battery cells can remain extremely hot and may re-ignite hours later.

References & Resources

Additional references and resources include:

- Recalls.gov: *Federal Recall Information*, U.S. Government, https://www.recalls.gov/.
- *Recalls & Product Safety Warnings*, U.S. Consumer Product Safety Commission (CPSC), https://www.cpsc.gov/recalls.
- U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration (PHMSA), *Lithium Battery Guide for Shippers* (Nov. 21, 2024), https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/2024-11/Lithium-Battery-Guide-2024.pdf.
- *What to Recycle*, The Battery Network, https://batterynetwork.org/battery-basics/what-to-recycle/.
- *Rechargeable Batteries*, The Battery Network, https://batterynetwork.org/battery-basics/what-to-recycle/rechargeable-batteries/.
- *Drop-off Locations*, The Battery Network, https://batterynetwork.org/locator/.

[12] U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, 49 CFR § 173.185, Lithium Cells and Batteries; PHMSA, Lithium Battery Guide for Shippers.

- *Battery Recycling Program*, District of Columbia Department of Energy and Environment (DOEE), https://doee.dc.gov/page/batteryrecycling.
- *Commercial Solutions*, Battery Recyclers of America, https://www.batteryrecyclersofamerica.com/commercial-solutions/.
- *Lithium-Ion Battery Safety*, National Fire Protection Association (NFPA), https://www.nfpa.org/education-and-research/energy-transition/lithium-ion-batteries.
- U.S. Department of Energy (DOE), Office of Environment, Health, Safety and Security (EHSS), *Operating Experience Summary (OES) 2025-02: Consideration of Lithium-Ion Battery Hazards in DOE Nuclear Facilities* (Oct. 27, 2025), https://www.energy.gov/ehss/articles/oes-2025-02-consideration-lithium-ion-battery-hazards-nuclear-facilities.

Standards and Other Defining Documents:

- **American National Standards Institute (ANSI)/Canada (CAN)/National Electrical Manufacturers Association (NEMA):**
  - ANSI/CAN/UL 2272, *Electrical Systems for Personal E-Mobility Devices*.
  - ANSI/NEMA C18, *Safety Standards for Primary, Secondary and Lithium Batteries*.
- **American Society for Testing and Materials (ASTM):**
  - ASTM F2951, *Standard Consumer Safety Specification for Baby Monitors*.
  - ASTM F963, *Standard Consumer Safety Specification for Toy Safety*.
- **Institute of Electrical and Electronics Engineers (IEEE):**
  - IEEE 1625, *Standard for Rechargeable Batteries for Multi-Cell Computing*.
  - IEEE 1725, *Standard for Rechargeable Batteries for Mobile Telephones*.
- **Underwriters Laboratories (UL):**
  - UL 1642, *Standard for Safety for Lithium Batteries*.
  - UL 2054, *Standard for Household and Commercial Batteries*.
  - UL 2056, *Outline of Investigation for Safety of Power Banks*.
  - UL 2595, *Standard for Safety for General Requirements for Battery-Powered Appliances*.
  - UL 4200A, *Standard for Safety for Products that Incorporate Button or Coin Cell Batteries Using Lithium Technologies*.
  - UL 60065, *Standard for Audio, Video, and Similar Electronic Apparatus—Safety Requirements*.

For questions about this OES, please contact Bart Drummond at barton.drummond@hq.doe.gov or the EHSS Office of Data Strategy and Performance (EH-33) by email at OEC@doe.gov.

Operating Experience Summary
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