Data Center Battery Overview

POWER SOURCES · UPS & THE BATTERY · LEAD-ACID / NI-CD / LITHIUM-ION · STANDARDS VS CODES · IEEE STANDARDS · IFC & NFPA FIRE CODES

STUDY & REVIEW

01 MUST KNOW

if you remember five things, remember these

01 **The power chain:** Utility power flows **grid → transformer → MDB → UPS → critical load**. The transformer sets the right voltage and type of current; the **MDB** routes power and draws on two sources — the grid and an on-premises **generator** — before the UPS feeds the equipment.

02 **The battery bridges the gap:** When the grid fails the **generator takes time to start**, so the UPS discharges its **batteries** to carry the critical load until the generator is ready; the MDB then transfers the load to generator power. The battery is the UPS's most important component and makes power through a **chemical reaction**.

03 **Three chemistries: Lead-acid**, **nickel-cadmium**, and **lithium-ion**. Lead-acid splits into **valve-regulated (VRLA)** — sealed, maintenance-free, the data-center choice — and **open-vented (flooded)** — unsealed, risky, and *not preferred*.

04 **Standards vs. codes:** A **standard** is a *voluntary* guideline from a designated authority (the IEEE grades them **guide → recommended practice → standard**). A **code** is a *legally imposed* regulation — violating it can bring **fines or imprisonment**. The IFC and NFPA set the fire codes.

05 **Hydrogen drives fire safety:** Lead-acid batteries emit **reactive, explosive hydrogen**, so battery rooms need **ventilation and spill containment**. **IFC Section 608** and **NFPA 1 Chapter 52** govern large stationary batteries by capacity — e.g., Section 608 applies above `70 kWh` for lead-acid/Ni-Cd.

02 KEY TERMS

TERM	DEFINITION
Uninterruptible power supply (UPS)	Power source that engages during a grid outage; stores utility power in batteries and supplies the critical load, filtering damaging variations and boosting uptime
Main distribution board (MDB)	Board that transfers power from the grid or generator to the equipment through the UPS; automatically switches to generator power when the grid fails
Generator	On-premises electricity-generation device used as the secondary power source during an outage; reliable but takes time to start
Transformer	Ensures the right voltage and type of current are supplied to the data center
Critical load	The essential data-center equipment the UPS protects with consistent, conditioned power
Self-discharge	A battery's tendency to lose charge through chemical leakage or aging while it sits idle
Sulfation	Damage that occurs when a lead-acid battery is left discharged, after which it can no longer be recharged
Valve-regulated lead-acid (VRLA)	Sealed lead-acid battery with pressure-relief valve vents; maintenance-free, mountable in any orientation, using AGM or gel electrolyte
Open-vented (flooded / wet cell)	Unsealed lead-acid battery whose plates are flooded with electrolyte; long-lived but vents hydrogen and needs manual watering — not preferred in data centers
Absorbed glass mat (AGM)	VRLA electrolyte held in a porous glass separator; the alternative is gel, a mixture of silica and sulfuric acid
Standard	A voluntary guideline from a designated authority on the best way to complete a task; the IEEE grades them as guide, recommended practice, or standard
Code	A regulation imposed by law and enforced by government authorities; non-compliance can bring fines or imprisonment

03 HOW POWER REACHES THE EQUIPMENT

the generator feeds the MDB as backup

01 **Power grid** — primary supply → 02 **Transformer** — correct voltage & current → 03 **MDB** — routes grid or generator power → 04 **UPS** — discharges its batteries → 05 **Critical load** — protected equipment

04 THE THREE UPS BATTERY CHEMISTRIES

match strengths and watch-outs to the use case

BATTERY	ELECTRODES / ELECTROLYTE	STRENGTHS	WATCH-OUTS
Lead-acid	Sponge lead + lead peroxide; sulfuric-acid electrolyte	Reliable, cost-effective, low maintenance, minimal self-discharge	Not eco-friendly (lead); standby duty only; ruined if left discharged
Nickel-cadmium	Nickel oxide + metallic cadmium; sulfuric-acid electrolyte	Long life; endures overcharge/ overdischarge; stores discharged; ultra-fast charge	Costly + toxic disposal; low `1.20 V` cells; high self-discharge
Lithium-ion	Li ions move negative → positive electrode	Built-in monitoring; small/high density; low self-discharge; little cooling	Costly; heat-sensitive; no rapid charge below freezing; needs protection circuit

05 LEAD-ACID SUBTYPES

VALVE-REGULATED (VRLA)

sealed — the data-center choice

- Sealed case with pressure-relief vents in the valve
- Maintenance-free; mount horizontally or vertically
- Absorbed glass mat (AGM) or gel electrolyte

OPEN-VENTED (FLOODED / WET CELL)

risky — not preferred in data centers

- Plates flooded with electrolyte; long battery life
- Not sealed — vents hydrogen into the environment
- Maintained manually by adding water to the top

06 STANDARDS & CODES TO KNOW

voluntary vs. legally imposed

BODY	TYPE	GOVERNS
IEEE (450, 485, 1184–1189, …)	Standard — voluntary	Selecting, installing, testing, maintaining large batteries; most widely accepted
IFC Section 608 (ICC)	Code — legal	Permits, location, max quantities, and suppression/detection for stationary battery systems
NFPA 1, Chapter 52	Code — legal	Fire & life safety; 52.3.6 ventilation holds hydrogen ≤1% of room volume or ≥1 `cfm/ft²`

07 EXAM TRAPS

where the knowledge check gets you

- × *The generator takes over the instant the grid fails.* — It does not. A **generator takes time to start**; the UPS discharges its batteries to carry the critical load until the generator is up, and only then does the MDB transfer the load.
- × *The UPS generates electricity.* — No. The UPS **stores** grid power in batteries while utility power is available and **discharges** it during an outage; generation is the job of the grid and the generator.
- × *Lead-acid batteries can be left sitting discharged.* — Leaving a lead-acid battery discharged causes **sulfation**, after which it **cannot be recharged**. Store them charged; they suit standby duty with limited discharge cycles.
- × *Open-vented (flooded) cells are the data-center default.* — The opposite: open-vented cells vent **hydrogen directly** and are risky, so they are **not preferred**. Data centers use sealed **valve-regulated (VRLA)** batteries.
- × *Nickel-cadmium has low self-discharge.* — Ni-Cd has a **high self-discharge**, so it is unsuitable for equipment that runs long-term at low power draw. Lead-acid and lithium-ion are the low-self-discharge chemistries.
- × *Lithium-ion charges fine in the cold and needs heavy cooling.* — Li-ion needs **little cooling**, but it **cannot be rapid-charged below freezing** (<0 °C, <32 °F), degrades at high temperature or stored voltage, and needs a **protection circuit**.
- × *Standards are legally binding.* — Standards are **voluntary** (they should still be followed); **codes** are the legally imposed regulations, and violating a code can bring **fines or imprisonment**.
- × *An IEEE guide and a recommended practice carry equal weight.* — A **guide** is the lowest level ('may'/'might', enforces nothing); a **recommended practice** is the middle level ('should'). They differ in degree of application.

08 SELF-QUIZ

answers are upside-down below

Q1 In the data-center power chain, which board transfers power from the grid or the generator to the equipment through the UPS?

Q2 Why is the UPS battery essential in the first moments of a grid outage?

Q3 Name the three types of UPS batteries.

Q4 What are the two subtypes of lead-acid battery the module identifies?

Q5 Which lead-acid subtype is not preferred in data centers, and why?

Q6 Which chemistry has a built-in monitoring and management system and high power density?

Q7 What condition ruins a lead-acid battery that is left in a discharged state?

Q8 How does a standard differ from a code?

Q9 Whose battery standards are the most widely accepted for selecting, installing, testing, and maintaining battery systems?

Q10 Under NFPA 1, 52.3.6, what is the maximum hydrogen concentration a battery-room ventilation system may allow?

ANSWER KEY (rotate the page)

Q1 The main distribution board (MDB) **Q2** A generator takes time to start, so the battery discharges to carry the critical load until the generator is ready **Q3** Lead-acid, nickel-cadmium, and lithium-ion **Q4** Valve-regulated (VRLA) and open-vented (flooded / wet cell) **Q5** Open-vented (flooded) — it is unsealed, vents hydrogen directly, and is considered risky **Q6** Lithium-ion **Q7** Sulfation — the battery can no longer be recharged **Q8** A standard is a voluntary guideline; a code is a legally imposed regulation with penalties for non-compliance **Q9** The IEEE (Institute of Electrical and Electronics Engineers) **Q10** 1% of the room volume (or continuous ventilation of at least 1 cfm per square foot)