NMC VS LFP

Lithium-Ion Battery Chemistries: NMC vs. LFP
Operational Training Document for First Responders

1. Purpose

This document provides first responders with a clear understanding of the differences between Nickel Manganese Cobalt (NMC) and Lithium Iron Phosphate (LFP) batteries. Responders will be able to quickly assess risks, anticipate fire behaviour, and choose appropriate mitigation strategies at incidents involving electric vehicles (EVs), energy storage systems (ESS), mobility devices, and consumer electronics.

2. Quick Comparison for Scene Awareness

Feature	NMC Batteries	LFP Batteries
Common Uses	Long-range EVs, power tools, e-bikes, aerospace	Buses, fleets, ESS, standard-range EVs, commercial energy systems
Energy Density	High	Medium-Low
Thermal Runaway Risk	Higher	Lower
Fire Severity	More intense, faster escalation	Less severe, slower escalation
Toxicity of Smoke	High (cobalt, nickel compounds)	Moderate (no cobalt/nickel)
Stability Under Damage	Less stable	More stable
Cold Weather Performance	Better	Worse

3. NMC Batteries – What Responders Must Know

3.1 Hazard Characteristics

Higher likelihood of thermal runaway when damaged, overcharged, or exposed to heat.
Fire intensity and flame plume are significantly stronger due to higher energy density.
Toxic smoke plume contains cobalt, nickel, and other heavy metals.
Cells may vent violently and can lead to cascading cell failure.

3.2 Scene Indicators

Found in:

- Long-range EVs (premium models)
- Many e-bikes, scooters, power tools
- Aviation/UAS systems

Typical signs of failure:

- Rapid heating, hissing, popping
- Jet-like flame plume during venting
- Thick black/grey smoke

3.3 Operational Considerations

- Maintain large collapse and projectile exclusion zones.
- Water remains the primary coolant—sustained, high-volume application required.
- Expect rekindle potential due to deep-seated energy pockets.
- PPE for cobalt-containing smoke: SCBA absolutely required.

4. LFP Batteries – What Responders Must Know

4.1 Hazard Characteristics

- More stable chemistry with significantly lower thermal runaway probability.
- Fires typically burn cooler and slower, offering more time to intervene.
- Smoke toxicity is lower but still hazardous.
- Often used in commercial fleet vehicles and energy storage systems, which may involve large quantities of cells.

4.2 Scene Indicators

Found in:

- Electric buses, delivery fleets
- Energy storage units (e.g., grid-connected cabinets)
- Residential/commercial ESS
- Standard-range EVs and many Chinese-built EVs

Failure indicators may be less dramatic than NMC:

- Cell swelling
- White/grey vapour
- Slow venting before ignition

4.3 Operational Considerations

Less violent reaction but large ESS installations require:

- 360° size-up
- Fixed suppression familiarity
- Ventilation hazard awareness (hydrogen, off-gas accumulation)

Reignition risk still exists; monitor temperature for extended periods.

5. Tactical Differences at the Scene

NMC Battery Incidents

- Expect rapid thermal escalation.
- Apply water immediately and continuously.
- Prepare for rapid flame jetting and cell ejection.
- Maintain larger standoff distances.

LFP Battery Incidents

- Slower escalation offers more time for mitigation. May emit more gas.
- Cooling is still required, but container integrity may hold longer.
- ESS units may contain multiple modules, increasing total event duration.

6. First Responder Safety Priorities

- PPE: Full PPE and SCBA mandatory.
- Standoff distance: Increase distance for NMC systems.
- Cooling: Use large volumes of water; establish sustainable supply.
- Thermal imaging: Monitor for hotspots long after flame knockdown.
- Reignite risk: Lithium-ion fires can rekindle hours or days later.
- Battery identification: If possible, determine the chemistry—this informs risk level.

7. When You Cannot Identify the Chemistry

If you cannot confirm whether the battery is NMC or LFP:

- Treat it as NMC

✓ Higher risk
✓ Faster escalation
✓ More hazardous off-gassing
✓ Greater flame potential

- Use maximum cooling and maintain large safe distances.

8. Summary for Responders

- NMC = Higher risk, more intense fires, faster escalation.
- LFP = Lower risk, more stable, slower escalation, more toxic gas and still dangerous.
- All lithium-ion batteries can cause fires, explosions, and toxic off-gassing.
- Water remains the most effective suppression and cooling method.
- Continuous monitoring and long-duration overhaul are essential.