Electric vehicle (EV) manufacturing must adhere to stringent safety standards to ensure the protection of users, workers, and the environment. Below are the key safety features and regulatory requirements for EV manufacturing according to **Indian (BIS & AIS Standards)** and **European (UNECE & EU Regulations)** standards:

**1. Battery Safety (Most Critical)**

**Indian Standards (AIS-038, AIS-048, AIS-156)**

* **Thermal Runaway Prevention**: Battery packs must have fire-resistant casing and cooling systems.
* **Overcharge/Over-discharge Protection**: Battery Management System (BMS) required.
* **Crash Safety**: Batteries must withstand impact (tested as per AIS-048).
* **IP67 Rating**: Protection against dust and water ingress.

**European Standards (UNECE R100, R136, EU 2019/631)**

* **Cell & Module Testing**: Must pass vibration, shock, and fire resistance tests.
* **Short-Circuit Protection**: Isolation monitoring and automatic cut-off.
* **Recyclability Compliance**: Follow EU Battery Directive (2023).

**2. Electrical Safety**

**Indian (AIS-038, IS 17017)**

* **High-Voltage Isolation**: Protection against electric shock (insulation resistance ≥ 500 Ω/V).
* **Leakage Current Protection**: Residual Current Device (RCD) mandatory.

**European (UNECE R100, IEC 61851)**

* **Automatic Discharge System**: High-voltage components must discharge when off.
* **Waterproofing (IPXXB)**: Protection against direct contact with live parts.

**3. Vehicle Structural Safety**

**Indian (AIS-096, AIS-098)**

* **Crashworthiness**: Frontal, side, and rear impact tests (similar to Euro NCAP).
* **Battery Mounting**: Must not dislodge in a crash.

**European (ECE R94, R95, Euro NCAP)**

* **Reinforced Body Structure**: Protects battery in collisions.
* **Pedestrian Safety**: Active hood or deformable structures.

**4. Charging System Safety**

**Indian (IS 17017, AIS-138)**

* **Overcurrent/Overvoltage Protection**: Chargers must comply with IS/IEC 60335.
* **Bidirectional Safety**: For V2G (Vehicle-to-Grid) compliance.

**European (IEC 62196, ISO 15118)**

* **Plug & Socket Safety**: Must have interlock mechanisms.
* **CCID (Charging Circuit Interrupting Device)**: Detects ground faults.

**5. Fire Safety & Emergency Systems**

**Indian (AIS-156, National Electric Mobility Mission Plan - NEMMP)**

* **Fire Detection & Suppression**: Recommended for passenger and commercial EVs.
* **Emergency Cut-off Switch**: Easily accessible for first responders.

**European (UNECE R94, R100, ISO 6469)**

* **Automatic Fire Suppression**: Required in buses and heavy EVs.
* **High-Voltage Disconnect**: Clearly marked for emergency crews.

**6. Software & Functional Safety**

**Indian (Draft AIS-180 for Cybersecurity)**

* **Fail-Safe Mechanisms**: Software must detect and mitigate failures.

**European (ISO 26262 - ASIL D, UNECE R155/R156)**

* **Cybersecurity**: Protection against hacking (mandatory from 2024).
* **OTA Updates**: Secure and authenticated firmware updates.

**7. Worker Safety in Manufacturing (OSHA & EU Directives)**

* **High-Voltage Training**: Workers handling batteries must be certified.
* **ESD (Electrostatic Discharge) Protection**: Anti-static flooring and tools.
* **Ventilation**: To prevent gas accumulation in battery assembly.

**Key Differences Between Indian & European Standards**

| **Feature** | **India (BIS/AIS)** | **Europe (UNECE/EU)** |
| --- | --- | --- |
| **Crash Tests** | AIS-096 (Partial) | Euro NCAP (Stricter) |
| **BMS Requirements** | Mandatory (AIS-038) | ISO 26262 (ASIL D) |
| **Recycling Laws** | Proposed (NEMMP) | EU Battery Regulation (2023) |
| **Cybersecurity** | Draft AIS-180 | UNECE R155 (Mandatory) |

**Conclusion**

EV manufacturers must comply with:  
✅ **Indian Standards (AIS-038, AIS-048, AIS-156, IS 17017)**  
✅ **European Standards (UNECE R100, R136, ISO 6469, IEC 62196)**  
✅ **Global Best Practices (ISO 26262, Euro NCAP, UNECE R155)**

Manufacturers exporting to Europe must meet stricter cybersecurity, recyclability, and crash safety norms, while Indian standards are evolving to align with global benchmarks.