



## Safety and Testing of Electric Vehicles

Anshul Sharma

Department of Mechanical Engineering,  
MIT School of Engineering,  
Pune, India  
Anshul7777sharma@gmail.com

Anilkumar Sathe

Department of Mechanical Engineering,  
MIT School of Engineering,  
Pune, India  
anilkumar.sathe@mituniversity.edu.in

**Abstract:** Electric vehicles (EVs) first showed up in the late 19<sup>th</sup> century, however in the light of Internal Combustion Engines somehow these were neglected. Now a day, because of increasing pollution of the total eco-system, again the e-mobility concept is started to gather pace. The change to EVs is being speed up by three variables - Tighter natural regulation (limitations on CO<sub>2</sub> outflows forced on vehicle producers and vehicle proprietors), Technological progressions (for example less expensive and all the more remarkable batteries, and framework for quicker charging) and Changing customer conduct (developing ecological mindfulness safety and acknowledgment of EVs). The shift to EVs compelling vehicle producers to foster new crossover and full-electric vehicle models testing. So testing and safety concerns are in greater demand in order to achieve a proper safe vehicle.

**Keywords:** Electric vehicles, safety and testing, EV, ICE, RESS

### I. INTRODUCTION

EVs are exposed to a similar thorough security testing and should fulfil similar wellbeing guidelines and homologation necessities as customary vehicles, notwithstanding extra EV norms. Luckily, EVs have wellbeing frameworks that segregate the battery naturally in case of an accident. At the point when the vehicle's different sensors recognize an impact, unique pyro-wires are enacted, cutting off the high voltage links and successfully separating all power.

Reasons for electric vehicles being not safe:

These EVs ordinarily burst into flames on the grounds that a short out inside at least one of the battery's cells creates heat in Lithium-particle batteries. The hotness can then touch off the synthetics inside the battery and contiguous cell, making the fire spread and develop quickly. India having differed climatic circumstances make it considerably riskier.

As per a battery industry master, India has massively high hotness and moistness, joined by fluctuating temperature the nation over, requiring more forceful and exhaustive testing of electric vehicle batteries to keep away from any possible issues. Sohinder Gill, Director General of the Society of Manufacturers of Electric Vehicles (SMEV), likewise advised producers against racing into localisation. He said that one of the fundamental explanations behind electric vehicle fires is heedless battery localisation.

In the current day, as per a report, lithium batteries utilize combustible fluid electrolytes, making them more inclined to

fire. Some experts believe that, unlike in an internal combustion engine, the fire can easily be controlled once the fuel has been consumed. Nonetheless, given electric vehicles controlled by lithium-particle batteries, even after the fire was doused, the batteries hold energy and can be utilized to reignite the fire.

### II. ELECTRIC VEHICLE (EV) TESTING

Electric vehicle (EV) testing goes far past homologation testing for the vehicles and their parts. It likewise covers the charging points of interaction and the related frameworks that empower EVs, charging stations and administrative center frameworks to speak with each other, known as interoperability or conformance testing. Battery packs and the modules they are made of, containing huge quantities of battery cells, are source of tremendous energy that can be a potential hazard consequently, so it must be tested.

Travelers situated above huge, high-voltage battery packs and a large number of electrical frameworks, Extreme caution to address the gamble of electric shock or breakout of a fire. This may be in case of an accident, forceful driving that causes overheating, or even harsh streets that vibrate the battery. Range uneasiness, charging rate and battery corruption are additionally key consideration.

The two providers and automakers run broad tests to refine how comfortable and quick an EV drives. Guaranteeing repeated fast speed increase without overheating is important factor.

Initially, a common buyer is probably not going to spot a lot of contrast between an electric vehicle (EV) and an internal combustion engine (ICE), there's an extra identification on the vehicle's back or a different hued number plate.

Their internals, in any case, differ tremendously:

#### A) Need of Testing in EVs

Accidents may lead to fire in batteries, usually the vehicles catch fire with sudden bump crash or shocks occurring due to accidents. This is generally because of leakage of Acid from batteries after accident. Hence there's a need of safe and reliable electrical systems throughout the vehicle. Testing gives us the understanding of what our limit will be in order to increase strength or reduce the composition of inflammable substance, may it be through proper insulation or shock proof coatings.

Both EV and HEV have Rechargeable Electric Storage system (RESS) which usually are the cause of burning or fire, but with proper structure and precautions it can be beneficial to the vehicle. The next cause is High Voltage equipment's, corrosive chemicals and toxic gases. Testing of vehicle gives us the wide range of probability which can harm vehicle driver or surrounding by checking the safety against electric shocks, protection against direct and indirect contact. Determining the voltage levels of different vehicles gives us understanding of what volt is required to maintain the proper balance avoiding disturbances:

Small cars – 48 V to 120 V.

Large Vans – 96 V to 240 V.

Buses – 300 V to 600 V.

These voltages used can cause serious shock, hence direct and indirect contact should be avoided. The vehicles are classified as follow in the diagram which gives us wide range and variety of class of vehicles to get the understanding of different requirements of EVs.

Model	Vehicle Class *	Description	Feature	Tandem Configuration
1	Mobile car			
2	Bus			
3	Small truck A			
4	Small truck B			
5	Mid-sized truck A			
6	Mid-sized truck B			
7	Mid-sized truck C			
8	Heavy truck A			
9	Heavy truck B			
10	Heavy truck C			
11	Heavy truck D			
12	Heavy truck E			

\* Vehicle class indicates the vehicle classifications presented by [13].

Fig. 1. Class of different vehicles

	Conventional CV	Hybrid-Electric HEV	Plug-in Hybrid Electric PHEV	Battery Electric BEV
Power Converter	Engine	Engine & Motor	Engine & Motor	Motor
Battery Pack	-	Small	Medium	Large
Gasoline	✓	✓	✓	
Electricity			✓	✓

Fig. 2. Types of vehicles

**B. Homologation of vehicles**

Homologation is the term for the entire vehicle endorsement process. It is the allowing of endorsement by an authority. This might be an official courtroom, an administration division, or an intellectual or expert body, any of which would ordinarily work from a bunch of rules or norms to decide if such endorsement ought to be given. It begins with starting appraisals observed by tests as per guidelines and mandates, up to the planning of validated specialized reports to forward to the experts to get the last endorsement.

Homologation gives different advantages to vehicle and parts makers:

Acquire legitimate admittance to target markets to create higher incomes, guarantee fast conveyance of your item to

buyers, keep away from expensive punishments and fines for rebelliousness/exorbitant reviews, support brand notoriety among purchasers and controllers by guaranteeing vehicle wellbeing.



Fig. 3. Components of vehicles

**Institutional Framework for Automotive Regulations**

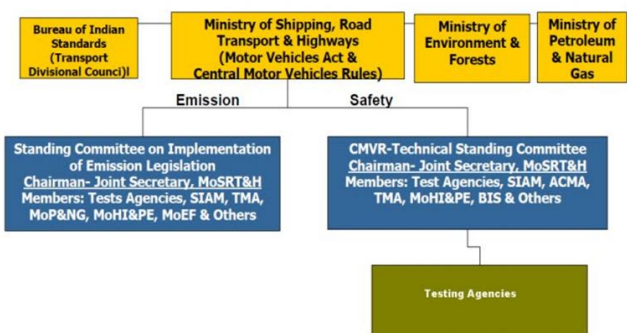


Fig. 4. Institutional frame work for automotive regulations

**C. Testing of Electric Vehicles**

There are number of tests through which a vehicle needs to pass in order to get a performance along with the safety of passengers and the environment.

They are discussed below:

1. Lighting technology testing: This test incorporates the testing of all boundary of lights present in the vehicles, including Headlights, LED lights, HID lights, Halogen, Driving lights, Parking lights, Direction-signal lights, Blinker lights, Stoplights, Backup lights, Taillights.
2. Wheel and tire testing: Tire testing is scrutinizing a tire, out and about, off the street, and under different other driving circumstances like different climate.
3. Simulation of ecological impacts: The natural recreation framework we accommodated vehicle testing, could deal with the temperature, stickiness, pressure, the nature of air, and so on. And furthermore can do the reenactment of wind, ice, downpour, snow, light, mist, sand dust, etc.
4. Battery testing: It is taking a voltage perusing, to estimating the interior opposition by a heartbeat or AC impedance strategy, to coulomb counting, and to taking a preview of the synthetic battery with Electrochemical Impedance Spectroscopy, contrasting it with the primary reading or desired reading.
5. Testing of electrical/electronic parts: Providing security of car electrical and hardware Components by showing consistence to appropriate principles. Explaining market access of electrical and electronic parts by satisfying pertinent nation guidelines

6. Testing of drive and vehicle parts: Vehicle testing and street tests are essential pieces of the whole item improvement cycle of assembling a car. Testing capacities with test vehicles or a concentrated model testing are fundamental to carry a vehicle to creation development.
7. Testing of frosting materials: It is trying the frosting materials in a vehicle which are the covered glass utilized for windshield and safety glass utilized for side windows, back window, and sunroof.
8. Testing of exhaust frameworks: During an exhaust examination, all of the exhaust framework's parts are outwardly reviewed for any breaks or other harm. Each of the cinches, mounts, and gaskets are likewise assessed
9. Testing of seats and belt moorings: During the safety belt port test, the dock point needs to oppose characterized static test loads applied by means of the water driven rams to address sway to test the appropriate capacity of the safety belt framework and its security efficiencies.
10. Testing of gas tanks: The first and clearest motivation to fill the tank with water is to guarantee the tank has no holes. The tank is loaded up with water at an endorsed rate and afterward analyzed following 24 hours to guarantee there are no breaks, pinholes, or different discontinuities in the welds.
11. EMI testing: EMI is the radiation waves produced by a gadget and impact on the climate. All electric and electronic gadgets emanate and get electromagnetic waves, these impede other electrical or electronic gear. With forestall hurtful impedances, electric gadgets need to comply to EMC rules. MI prompts deterrent or debasement of the exhibition of any electrical gear by inciting undesirable flows and voltages in its hardware.

### Examples of tested items

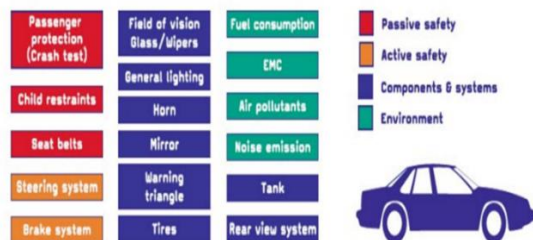


Fig. 5. Tested items

### III. SAFETY AND SAFETY CHECK IN VEHICLES

Consistently an expected 1.25 million individuals get injured due to street car accidents, and millions more are harmed. The World Health Organization has blended proof based measures that can fundamentally decrease street traffic fatalities and wounds. Auto security is the review and practice of plan, development, hardware and guideline to limit the event and outcomes of car accidents including engine vehicles. Street traffic wellbeing all the more comprehensively incorporates street plan. Safe vehicles assume a basic part in deflecting accidents and decreasing the probability of genuine injury. Be that as it may, just 40 nations as of now meet all need wellbeing guidelines with engine vehicle production and use all over the planet extending quickly, the attention on vehicle security opens new innovation based open doors for diminishing street crashes and their effect. Some significant security tests or measures are explained:

#### A. Crash Safety

Driven by extreme mileage and CO<sub>2</sub> outflow guidelines, the vehicle business encounters a central change. Without a doubt, crossover and battery electric vehicles will assume a significant part later on individual traffic, with the emphasis on the appropriateness for everyday use, adequate cruising reach, and energy charging time, at sensible expense. The way to accomplish these objectives will be the energy stockpiling innovation, with Lithium-particle batteries as a future base. Since these new high voltage frameworks include a significant difficulties concerning useful security and working wellbeing and crash security, a similarly significant rule for the acknowledgment of on the other hand driven vehicles by the overall population will be similar high security guidelines as laid out for regular vehicles. - A wise mix idea for the high voltage battery to implement basic harms regardless of whether straightforwardly affected during an accident.

- The carrying out of high necessities to the mechanical steadiness of all high voltage parts, joined with an extreme shock-verification security by cut-off and release during any mishaps.
- The reliable security of other street clients (similarity) alongside an upgraded execution of the new driver help and crash evasion frameworks.

#### B. High Voltage Cut-Off in the Event of an Accident

1. In minor extreme mishaps, for example front facing crashes with enactment of the safety belt assumptions or the first phase of airbags, the high-voltage framework will be closure reversibly. After the self-finding has not distinguished any protection blames, the HV-framework will be re-actuated, the motor of vehicles still drivable can be re-begun.

2. In any extreme mishaps (for example airbags completely terminated in front facing crash), the HV-framework will be cut-off irreversibly. For this situation, a re-beginning of the motor might be conceivable after a conclusion or fix has been led at an approved help station.

#### C. Protection against flooding testing in EVs

The ground-issue location framework continually tests for electrical associations between the metal vehicle body and the high voltage framework. (The two must consistently stay detached from one another). On identification of such a shortcoming, the ground-issue framework will stop the electrical inventory to the high voltage parts. Also, there are a progression of wires inside a battery pack to disengage various regions inside the pack if necessary.

EVs are intended to satisfy global guidelines on water entrance and as such ought to be protected experiencing the same thing. They additionally have an assortment of security frameworks intended to limit the probability of an electrical short out or potential for electrical shock in case of an accident or where a shock-peril is recognized.

As a totally electrical framework, electric vehicles accompany intrinsic security conventions that can forestall the release of high voltage flow in the event of a break in the wellbeing systems.

In any case, supported, weighty flooding might in any case make water enter the battery parts, which can be perilous as lithium (in the batteries) responds forcefully with water, delivering profoundly combustible hydrogen. There is a blast risk, yet such circumstances are interesting, and requires an intentional carelessness to get it going. Profound, saltwater is



harming to any vehicle however, as it is destructive in nature. If there should be an occurrence of electric vehicles, it can saturate the electrical parts and obliterate something very similar.

#### D. Protection against direct contact with live parts

- The protections used (Solid insulator, barrier enclosure etc.) shall not be opened, disassembled or removed without the use of tools.
- There are different degrees of protection which can be applied Based on the category of the vehicles.

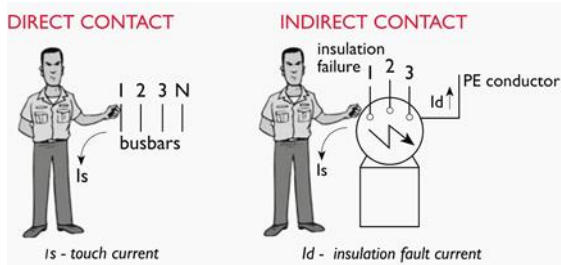


Fig. 6. Precaution against contact

#### Access Probe:

Access tests to check the assurance of people against admittance to live parts.

#### Test Conditions:

The entrance test is pushed against any openings of the nook with the power determined. If it mostly or completely enters, it is put in each conceivable position, however for no situation will the stop face completely infiltrate through the opening.

Internal barriers should be considered part for the enclosure.

A low-voltage supply (of at least 40 V and not in excess of 50 V) in series with a reasonable light ought to be associated, if fundamental, between the test and live parts inside the obstruction or stop the light source.

The sign circuit technique ought to likewise be applied to the moving live pieces of high voltage gear.

### IVE Combined Protection against Both Direct & Indirect Contact

- By Separated Extra-Low Voltage (SELV) System
  - It is extra-low voltage system without connection to earth
- By Limitation of Discharge of Energy
  - The equipment incorporates means of limiting the current which can pass through the body of a person to a value lower than that likely to cause danger
  - However, the open circuit voltage is not limited  
E.g. equipment with power source and very high internal impedance

Fig. 7. Protection against contact

#### E. Assurance against unnecessary current

- The REESS will not overheat.
- In the event that it overheats assurance ought to be carried out
- Wires
- Circuit breakers

The prerequisite may not emerge assuming the maker supplies information that overheating from unnecessary current is forestalled without assurance gadget.

*Security against water impact:* Wet vehicle will conform to the segregation opposition with 100 Ohm/V of ostensible voltage.

*Washing:* Washing test ought to be directed to really look at any ongoing spillages and vehicle activity in the wake of washing.

*Flooding:* Intended to reenact driving of EPTV on overflowed roads.

## IV. CONCLUSION

With engine vehicle production and use all over the planet extending quickly, the attention on vehicle wellbeing opens new innovation based open doors for lessening street crashes and their effect. There is obvious proof that laying out and upholding vehicle wellbeing guidelines decrease street traffic fatalities, wounds and related financial expenses.

Testing limits with test vehicles or a genuine model testing are crucial to convey a vehicle to creation advancement. After the start of production (SOP), vehicle testing and road tests contribute in huge measure to guaranteeing the idea of the entire vehicle, vehicle systems, or parts. EV automakers have taken the going with additional prosperity protections,

The Indian certification workplaces ARAI and ICAT are encouraging the ability to test batteries and electric vehicles. A couple of subject matter experts and inspectors acknowledge that EVs are correspondingly basically as safeguarded as ICEVs. As demonstrated by various reasons, electric vehicles have less frictional parts than internal combustion engines, achieving least mileage trouble.

Batteries, like another fuel, store energy and must thusly be handle suitably. Electric vehicles are undeniably safer than fuel vehicles, with undeniably less episodes of issues. Consistently, in excess of 50,000 vehicle fires occur in the United States, as demonstrated by the FEMA report (gas vehicles). According to Chetan Maini, with the fast improvement of electric vehicles in India, a more critical highlight on prosperity is required.

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