Achieving Global Market Access for xEV Battery Systems

A closer look at key safety and performance requirements

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White paper

Abstract

As the market for advanced electrified vehicles (xEVs) continues to expand globally, developers and original equipment manufacturers (OEMs) are confronting a growing array of regulations and standards addressing the safety and performance of the rechargeable battery systems used to power these vehicles. Although many of these regulations touch on similar considerations, there are also important differences that must be taken into account during the various stages of battery design. Further, the regulatory approval process in key markets is often unique to a given country, and requires a specialized approach to navigate successfully.

In this white paper, we'll discuss the key safety and performance issues that must be addressed in all xEV battery designs, as well as the specialized requirements that apply to xEV battery systems in the EU, the U.S., China and other important markets around the world. We also discuss how TÜV SÜD is working with OEMs in the automotive industry to navigate the homologation process and to gain global market access for their products.

Contents

About the TÜV SÜD expert

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The state of xEV deployment

The uncertain economic environment brought on during the 2020 global pandemic has had a dramatic impact on the automotive industry. According to data from the International Energy Agency (IEA), global demand for automobiles during the first four months of 2020 declined nearly one-third from 2019 levels, with some countries recording monthly declines of 80% or more.[1] A separate assessment by the European Automobile Manufacturers' Association (ACEA) estimates that total sales of new passenger vehicles in the EU dropped over 40% between mid-March and the end of May.

During this challenging period of 2020, the continued demand for xEVs represented an important area of growth for the automotive industry. The IEA also reports that during the same January-April 2020 period, the sale of xEVs in the EU's largest automotive markets (France, Germany and Italy) increased by approximately 90%. Separately, the United Kingdom's Society of Motor Manufacturers and Traders notes that registration of battery electric vehicles (BEVs) in the UK during May 2020 were up 21.5%, versus a decline of about 90% for conventional vehicles.[2] The international consultancy Delta-EE estimates that half of the vehicles sold in Norway during the first five months of 2020 were xEVs, with plug-in hybrids representing an additional 20% of sales.[2]

Government subsidies, programs and campaigns to reduce carbon-based emissions have played an important role in encouraging buyers to consider xEVs. But, for many consumers, larger concerns regarding the long-term safety and health of the world's population have reinforced the importance of adopting innovative technologies that can provide long-term, sustainable solutions to address global climate change and other environmental issues. Because they generate significantly less emissions than comparable gasoline- and diesel-powered vehicles, the widespread use of xEVs can have a significant impact on the future of our planet and its population.

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Opportunities and challenges with xEV batteries and battery systems

Continuous innovation in batteries and battery systems will be an essential factor in the expanded acceptance of xEVs by consumers.

Continuous innovation in batteries and battery systems will be an essential factor in the expanded acceptance of xEVs by consumers. As such, researchers, automotive manufacturers and battery OEMs are making significant investments to identify potential improvements in existing lithium-ion battery configurations to increase battery energy and vehicle operating range. Further, experiments in battery chemistry such as the use of silicon instead of graphite to store lithium or the application of solid electrolytes are expected to soon lead to the development of xEV batteries capable of supporting driving ranges in excess of 500 miles/800 kilometers per charge and thousands of recharges, often proclaimed as the "million-mile-battery".[3]

However, incorporating new and advanced battery technologies into the design of new xEV batteries and battery systems presents several challenges. Of course, battery safety has always been and will remain paramount in the consideration of any new or innovative battery design. But there are other issues that xEV manufacturers and xEV battery OEMs must also consider. These considerations can include:

- **Battery performance** – Does the battery meet specifications regarding the energy delivered to the vehicle powertrain? Does the battery maintain predicable charge and discharge rates during normal operation? Do operators routinely achieve the advertised driving range on a full battery charge? Are the cooling systems and battery aligned to deliver the promised performance?

- **Battery maintenance** – What is the extent and frequency of maintenance or service required for an xEV battery to deliver anticipated performance? Does prescribed battery maintenance require the use of trained technicians, or can some or all services be performed by the vehicle operator?

- **Environmental issues** – Is the battery designed to operate under extreme environmental conditions, such as excessive heat or cold or high humidity levels? Can the battery be exposed to excessive amounts of dust or other airborne particles without affecting its operation?

- **Unanticipated safety concerns** – How is the safety of the battery affected by unanticipated situations, such as the immersion of the xEV in either salt or freshwater storm surges?

- **Transportation safety** – Does the battery meet UN requirements regarding the safe transportation of batteries aboard aircraft?

- **Battery "second-life" issues** – Does the design of the battery facilitate the recycling of key battery components and chemicals when it has reached its predicted end-of-life? Alternatively, could a battery that is no longer suitable for use in an xEV be used in another application?

These and other factors are important, not only because they have the potential to impact manufacturers' warranty-related expenses, but because battery failures can lead to explosions or sudden vehicle shutdowns, potentially resulting in injuries and even death. Even in the case of non-safety related failures, poor xEV battery performance can adversely influence consumer perceptions of a given brand of xEV in an increasingly competitive market.

Finally, for producers of xEV battery and battery systems, the acceptance of their products is also dependent on successfully demonstrating compliance with the requirements and standards imposed by regulatory authorities in major automotive markets around the world. However, the development of homologation structures applicable to xEVs and xEV components is still evolving in many countries, resulting in a continuously shifting homologation landscape. In addition, while there are requirements in the product review and approval process that are common in many jurisdictions, there can also be small but significant differences that require modifications to standard testing protocols or the application of additional test.

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The UN World Forum for the Harmonization of Vehicle Regulations and UNECE Regulation No. 100

Established in the early 1950s, the United Nations' World Forum for the Harmonization of Vehicle Regulations is responsible for harmonizing global technical requirements and protocols for the homologation of all types of vehicles and vehicles components. Towards that end, the World Forum has promulgated more than 150 different regulations that address multiple aspects of vehicle safety, energy efficiency and environmental protection.

LIST OF SIGNATORY COUNTRIES TO THE UN WORLD FORUM FOR THE HARMONIZATION OF VEHICLE REGULATIONS[4]

Albania
Armenia
Bosnia and Herzegovina
Bulgaria
Croatia
Czechia
Denmark
Egypt
Estonia
European Union
Finland
France
Georgia
Germany
Greece
Australia
Austria
Hungary
Italy
Japan
Kazakhstan
Latvia
Lithuania
Luxembourg
Malaysia
Montenegro
Netherlands
New Zealand
Nigeria
North Macedonia
Norway
Azerbaijan
Belarus
Pakistan
Poland
Portugal
Republic of Korea
Republic of Moldova
Romania
Russian Federation
San Marino
Serbia
Slovakia
Slovenia
Belgium
South Africa
Spain
Sweden
Switzerland
Thailand
Tunisia
Turkey
Ukraine
United Kingdom of Great Britain Northern Ireland

More than 50 countries are signatories to the 1958 Agreement that provides the legal framework for the World Forum's activities. That framework includes provisions for the mutual recognition of type approvals or certificates of conformity issued by regulatory authorities in signatory countries for vehicles and vehicle components that are found compliant with those regulations.

UNECE Regulation No. 100, Uniform provisions concerning the approval of vehicles with regard to specific requirements for the electric powertrain, is the internationally recognized standard for rechargeable energy storage systems (REESS) used in xEVs. The second revision of R100 (as the Regulation is commonly referenced) was published in 2013 and provides an expanded set of specific tests applicable to REESS and rechargeable battery packs.

The essential requirements in R100 are categorized as Part II requirements and are described in Section 6 of the Regulation. Annex 8 of the Regulation provides detailed information on the specific procedures necessary for assessing the safety of REESS. The assessment is intended to evaluate factors related to the safety and integrity of the battery pack itself, and includes the following tests:

- **Vibration** – The vibration test subjects REESS to 12 separate cycles of vibrations of varying intensities over a 15-minute period

to simulate the vibration likely to be experienced during normal vehicle operation.

- **Thermal shock and cycling** – This test subjects REESS to 5 separate cycles of exposure to temperatures of 60 degrees Celsius for 6 hours, followed within 30 minutes to temperatures of –40 C for an additional 6 hours.

- **Mechanical shock** – The mechanical shock test verifies REESS integrity under inertial loads comparable to those that might be experienced in a vehicle crash or other conditions. It involves acceleration and deceleration according to durations and shock values defined in the Annex.

- **Mechanical integrity** – Similarly, the mechanical integrity test verifies REESS integrity under contact loads that might be experienced in a vehicle crash. It involves the crushing of the REESS between a resistance and a crash plate with a force of at least 100 kN with an onset time of less than 3 minutes and a hold time of at least 100 ms.

- **Fire resistance** – This test verifies whether an REESS' resistance to exposure to fire originating outside the vehicle provides sufficient escape time for occupants. Testing can be performed with the REESS installed in the vehicle, or as a standalone component.

- **External short circuit protection** – The external short circuit protection test verifies the ability of an REESS to interrupt or limit a short circuit from leading to a fire or the explosion of the device. It is conducted by connecting the positive and negative terminals of the device to evaluate the effectiveness of the protection function.

- **Overcharge protection** – This test verifies the effectiveness of an REESS's overcharge protection function, and involves charging the device until the charging is stopped or interrupted by the protection function.

- **Over-discharge protection** – Similarly, the over-discharge protection test verifies the effectiveness of an REESS's over-discharge protection function, and involved discharging the device until the discharging is stopped or interrupted.

- **Over-temperature protection** – Finally, the over-temperature protection test verifies the protective measures to prevent internal overheating of the REESS during operation. It involves heating the device in climate-controlled chamber while it is being charged and discharged until the internal temperature is stabilized.

The challenges with the homologation process for xEV batteries and battery systems

As previously noted, under the terms of the World Forum's Agreement, xEV batteries and battery systems that have been found compliant with the safety requirements of R100 and that have received type approval from the regulatory authority in one of the Forum's signatory countries can be legally imported, sold and used in other signatory nations. However, in practice, there are several limitations in the application of the Forum's mutual recognition framework.

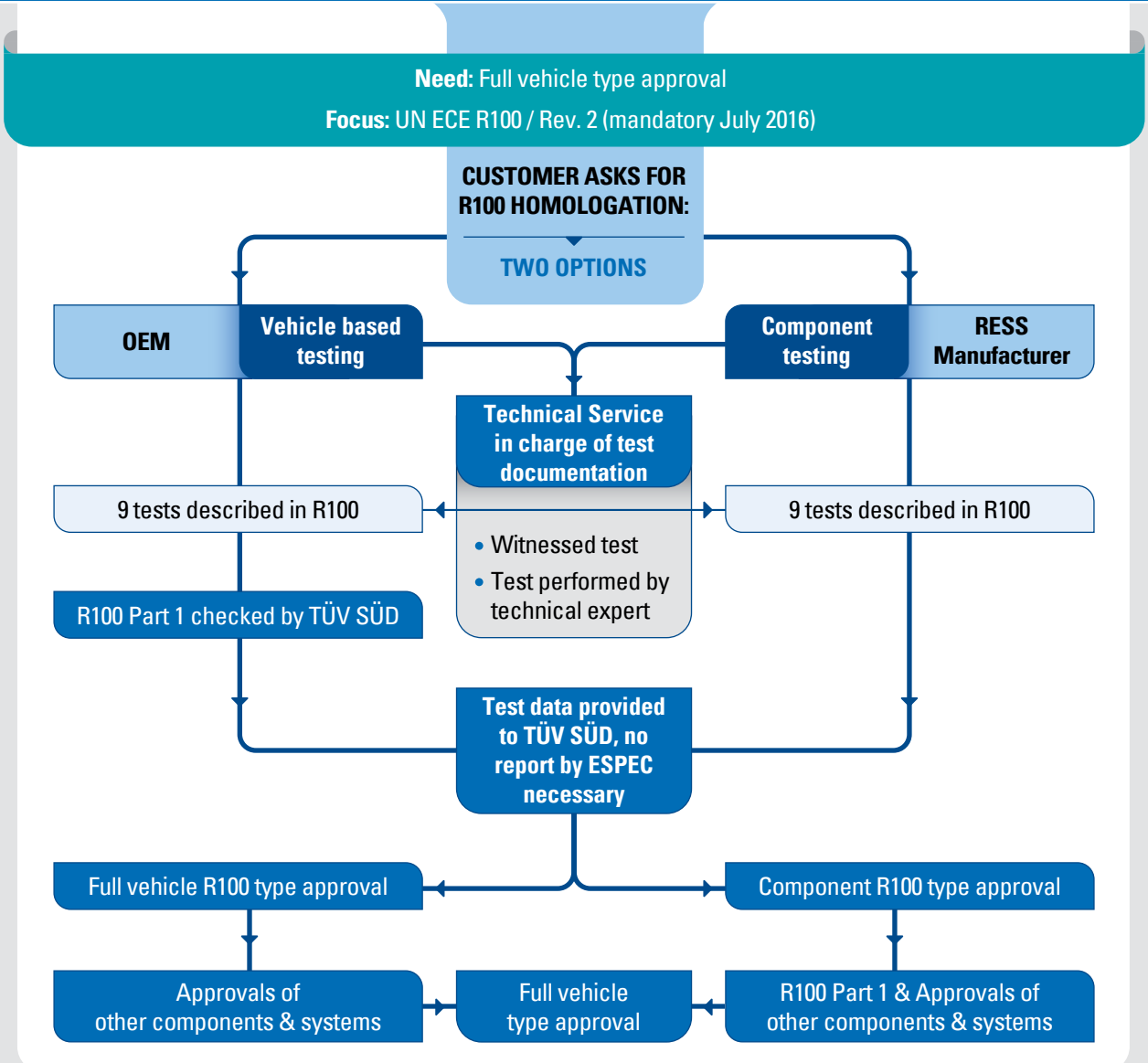
First, while several countries are signatories to the Forum's Agreement, there are several countries representing major global automotive markets that are not. Signatory countries include all EU member states, as well as

There are important differences in the approaches that approval authorities in individual countries and jurisdictions apply to the homologation process.

Australia and New Zealand, Japan and Thailand. However, neither the U.S. nor Canada are party to the Forum's Agreement. China, one of the world's largest and fastest growing markets for xEVs, is also not a signatory to the World Forum Agreement. That means that OEMs of xEV batteries and battery systems seeking access to those countries may need to comply with additional requirements and conduct additional testing to demonstrate compliance with the relevant regulations.

Second, even though type approvals for xEV batteries and battery systems issued in World Forum signatory countries are legally equivalent in theory, there are important differences in the approaches that approval authorities in individual countries and jurisdictions apply to the homologation process. The issuance of type approvals by some national authorities may adhere to a more rigorous process in the application of the World Forum's regulations to the review and approval of automotive components. While a more rigorous homologation process for components may be preferred by some automotive manufacturers, it can also involve lengthier and more in-depth testing for xEV battery OEMs.

SIMPLIFIED TYPE APPROVAL SCHEDULE: FOCUS ON UNECE R100 REVISION 2



Battery homologation in major automotive markets

In this section of the white paper, we'll discuss the homologation process for xEV batteries and battery systems currently in place in several major automotive markets.

SOURCE FOR VALIDATION STANDARDS AND REGULATIONS FOR xEVs

EU	USA	CHINA
International Standardization Organisations (e.g. ISO, IEC)		
e.g. DIN – German Institute for Standardization	ANSI – American National Standards Institute	SAC – Standardization Administration of the P.R. of China
Mandatory Regulations ECE	**Mandatory Regulations** FMVSS	**Mandatory Regulations** GB
National / Industry Standards e.g. DIN, VDI, VDE, VDA	**National / Industry Standards** e.g. ANSI, SAE, UL	**National / Industry Standards** e.g. SAC, GB/T, QC/T

KEY STANDARDS AND REGULATIONS FOR xEVs

EU	USA	CHINA
UN 38.3		
IEC 62660-1/2/3: Secondary lithium-ion cells for the propulsion of electric road vehicles – Performance test / Abuse test / Safety requirements		
ISO 12405-1/2/3: Electrically propelled road vehicles – Test specification for lithium-ion traction battery packs and systems: • Part 1: High-power applications • Part 2: High-energy applications, performance & abuse (SC, OC, OD) • Part 3: Safety requirements for tests of part 1&2 + additional tests & clarification		
ECE R100 Rev. 2 **Mandatory from 07/2016** Annex 8: Nine tests for batteries/vehicles 8A Vibration 8B Thermal Shock 8C Mechanical Shock 8D Mechanical Integrity 8E Fire resistance 8F External Short circuit protection 8G Overcharge protection 8H Over-discharge protection 8I Over-temperature protection	**FMVSS 305** Limits allowed electrolyte leakage and isolation for xEVs tested according to FMVSS 208, FMVSS 214, FMVSS 301 **SAE J2464** 15 abuse tests on cell / module / pack Mechanical / thermal / electrical tests **SAE J2929** Defines safety requirements for tests of SAE J2426 + additional tests & clarifications	**GB/T 31484, GB/T 31486** Performance cell / module **GB 38031-2020** Traction battery safety requirements for xEV batteries and battery systems

01 European Union

The EU represents the largest block of countries that are signatories to the World Forum Agreement, thereby providing an important gateway to the global automotive market for OEMs of xEV batteries and battery systems. Regulation (EU) 2018/858, which establishes a framework for the type approval of most types of motor vehicles, systems and components in the EU, expressly references UNECE Regulations, stating in Article 57:

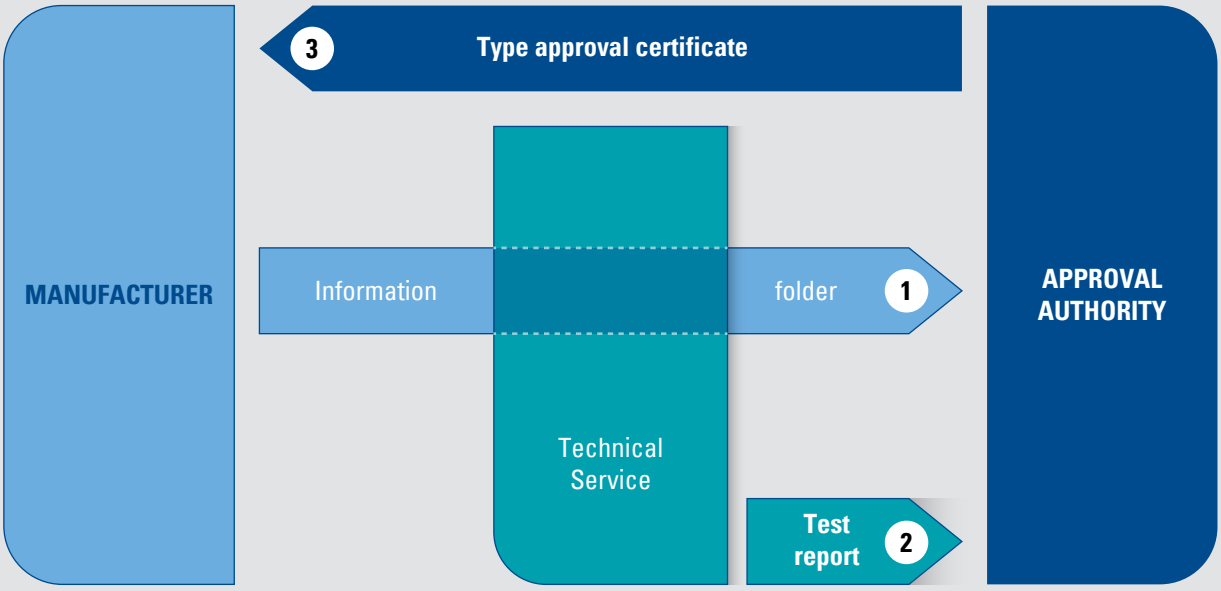
"UN Regulations or amendments thereto which the Union has voted in favour of, or that the Union applies and that are listed in Annex II, shall be part of the requirements for EU type approval of vehicles, systems, components or separate technical units."[5]

Further, Article 58 reinforces the equivalence of UNECE Regulations and EU Directives and Regulations, stating:

- *The UN Regulations listed in Part II of Annex II are recognized as being equivalent to the corresponding regulatory acts to the extent that they share the same scope and subject matter.*
- *The approval authorities of the Member States shall accept type approvals, granted in accordance with the UN Regulations referred to in paragraph 1 and, where applicable shall accept the relevant approval marks in place of the corresponding type approvals and approved marks that were granted in accordance with this Regulation and the regulatory acts listed in Annex II.*[6]

However, although demonstrating compliance with the requirements of UNECE R100 is an essential part of the approval process, xEV battery OEMs must still navigate a complex set of steps to successfully achieve EU type approval for their products. These steps include selecting one of the three testing approval routes authorized under the Directive. They also include preparing and assembling the required documentation (referred to as the "information folder" in the Regulation) that includes detailed specifications of the xEV battery, drawings, photographs, test reports and other technical information as required.

THE EU REGULATED TYPE APPROVAL PROCESS



Further, under the UNECE's type approval scheme, a recognized "technical service" needs to conduct or witness testing and report testing results to the chosen approval authority. The approval authority in turn reviews and recognizes the testing results and assigns a registration number together with an E-mark. We are recognized as technical service by 9 authorities.

SOME CURRENT COUNTRY CODES FOR "E" NUMBERS[7]

1 Germany	21 Portugal	41 (currently vacant)
2 France	22 Russian Federation	42 European Community
3 Italy	23 Greece	43 Japan
4 Netherlands	24 Ireland	44 (currently vacant)
5 Sweden	25 Croatia	45 Australia
6 Belgium	26 Slovenia	46 Ukraine
7 Hungary	27 Slovakia	47 South Africa
8 Czech Republic	28 Belarus	48 New Zealand
9 Spain	29 Estonia	49 South Cyprus
10 Serbia	30 (currently vacant)	50 Malta
11 United Kingdom	31 Bosnia and Herzegovina	51 South Korea
12 Austria	32 Latvia	52 Malaysia
13 Luxembourg	33 (currently vacant)	53 Thailand
14 Switzerland	34 Bulgaria	54 Albania
15 (currently vacant)	35 Kazakhstan	56 Montenegro
16 Norway	36 Lithuania	57 San Marino
17 Finland	37 Turkey	58 Tunisia
18 Denmark	38 (currently vacant)	60 Georgia
19 Romania	39 Azerbaijan	62 Egypt
20 Poland	40 Macedonia	

02 North America

More than 50 individual Federal Motor Vehicle Safety Standards (FMVSS) address a wide variety of automotive systems and components.

As previously noted, the U.S. is not a signatory to the World Forum's Agreement. Instead, the U.S. National Highway Transportation and Safety Administration (NHTSA) has developed vehicle standards intended to establish requirements for motor vehicles consistent with U.S. law. More than 50 individual Federal Motor Vehicle Safety Standards (FMVSS) address a wide variety of automotive systems and components, including air bags, seat belts and other passenger restraint systems, child passenger safety features, brakes, tires and electronic stability control systems.

FMVSS 305, Electric-powered vehicles: electrolyte spillage and electrical shock protection, is the FMVSS to which manufacturers of xEV battery systems must self-certify. As its title suggests, the standard specifies requirements for limiting electrolyte spillage and retention of electric energy storage and conversion devices during and after a crash, as well as protection from harmful electric shock during and after a crash as well as during normal vehicle operation.

Self-certification to the requirements of FMVSS 305 must be based on credible test data, and most OEMs rely on third-party testing organizations to conduct the rigorous testing necessary to verify compliance. To meet the procurement requirements of U.S.-based vehicle manufacturers, many battery OEMs also test their products to verify compliance with the requirements of UNECE R100, which support claims that the battery meets "state-of-the-art" design criteria due to its widespread usage. In this way, OEMs can reduce the potential liability attributable to poor product design by considering the unique characteristics of their battery design and applying the requirements of the standard to their product.

Canadian Motor Vehicle Safety Standards (CMVSS) are generally aligned with their U.S. FMVSS counterparts and the process for self-certification is comparable. However, CMVSS require that product labels and manuals include both English and French text.

03 China

China, the largest automotive market in the world, is also not a signatory to the World Forum's Agreement, but the country has some of the most comprehensive legal requirements applicable to the safety of xEVs. Early in 2020, China's Ministry of Industry and Information Technology (MIIT) issued three new national standards for xEVs and their batteries. The new standards represent an effort by China's authorities to more closely align the country's requirements with international regulations and standards, including the UNECE's Global Technical Regulation (GTR) No 20, Electric Vehicle Safety.

The new standards are:

- GB 18384-2020, which addresses safety requirements for xEVs;
- GB 38032-2020, which addresses safety requirements for electric buses; and
- GB 38031-2020, which addresses traction battery safety requirements for xEV batteries and battery systems.

GB 18384-2020: ELECTRIC VEHICLES SAFETY REQUIREMENTS

High voltage safety	**High voltage label requirement**	
	Protection against direct contact	Requirement of barrier/housing
		Connector requirement
		Requirement of service disconnect
		Charging port requirement
	Protection against indirect contact	Requirement of isolation resistance
		Requirement of isolation resistance monitoring
		Requirement of potential equilibrium
		Capacity coupling requirement
		Charing port requirement
	Water protection requirement	
Functional safety	**Power-on and power-off program of electric drive system**	
	Driving	Power derating indication
		Low SOC indication of REESS
		Thermal incident indication of REESS
		Brake first
	Reverse driving	
	Parking	
	Lock the connection of vehicle and charging station	

Light blue parts are relevant to traction battery

GB 38032-2020: ELECTRIC BUSES SAFETY REQUIREMENTS

General safety requirement	
IP safety requirement	Requirement of vehicle wading
	IP requirement of B class circuit
	Requirement of vehicle immersion
Fire prevention safety requirement	Thermal propagation test for minimum management unit of battery system
	Antiflaming requirement of REESS parts material
	Insulation requirement of compartment of installation REESS
	Requirement of disconnecting device of REESS
	Installation requirement of pressure release device of REESS
	Requirement of abnormity warning
Safety requirement of control system	Requirement of brake first
	Requirement of controlling power assist system during driving
Safety requirement of charging	Requirement of charging port
	Requirement of temperature monitoring for charring port
Safety requirement of vehicle post crash and post rollover	Safety requirement of vehicle post crash
	Safety requirement of vehicle post rollover

Light blue parts are relevant to traction battery

The new GB 38031 replaces China's GB/T 31485-2015, which details safety requirements and test methods for xEV traction batteries, and GB/T 31467.3-2015, which details safety requirements and test methods for xEV lithium-ion traction battery packs and systems. (Note that GB/T 31484 and GB/T 31486 are still applicable.)

Most notably, GB 38031 deletes all tests applicable to battery modules, focusing exclusively on battery cells and packs. In addition, the standard deletes drop testing, nail penetration testing and seawater immersion testing from the evaluation of battery cells, while deleting drop testing and rollover testing from the evaluation of battery packs. Finally, GB 38031 revises procedures for vibration, mechanical shock, crush and overcharge protection testing, while introducing new testing procedures for overcurrent protection and thermal propagation.

Along with GB 18384 and GB 38032, GB 38031 has been approved by China's State Administration of Market Supervision and Administration and the country's National Standardization Management Committee. Compliance with the requirements of each of the new standards will be mandatory as of January 1, 2021. At that point, OEMs of xEV batteries and battery systems can obtain a China Compulsory Certificate (CCC) verifying the compliance of their products.

In China, the xEV battery homologation process requires the use of a third-party testing laboratory that has been recognized by the MIIT. The recognized laboratory is responsible for testing the battery and for preparing a test report verifying compliance with the relevant GB standards. The test report is then submitted to the MIIT, which issues the CCC and registers the battery for use.

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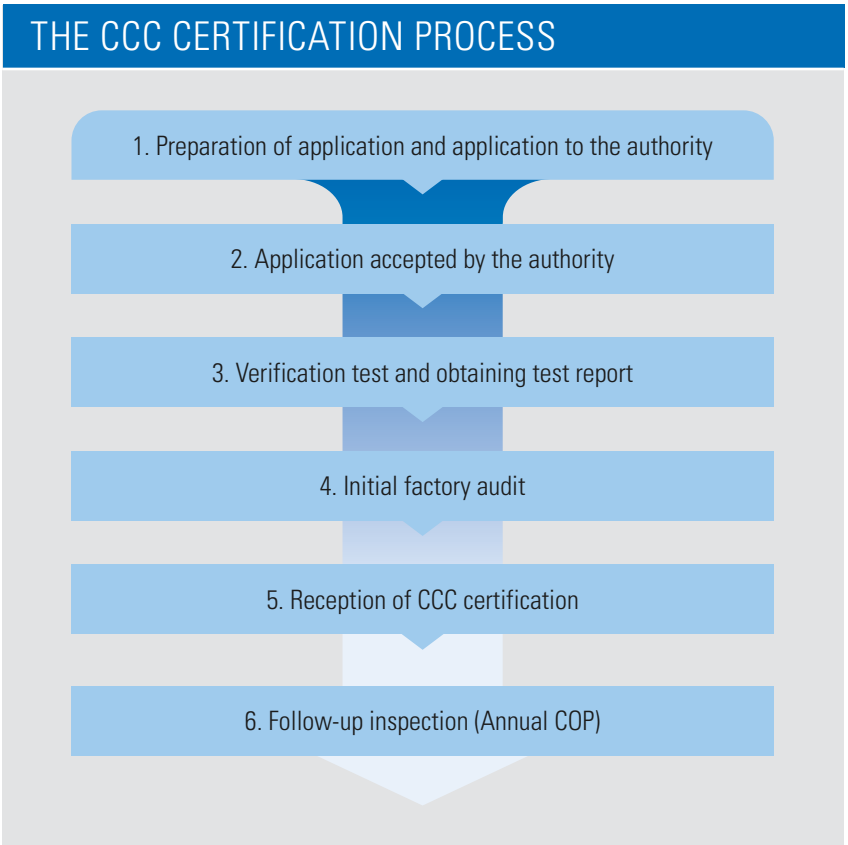
It is important to note that the homologation process with the MIIT applies to the battery as a component, but does not imply that the battery is homologated itself, or can be homologated without being connected to a whole vehicle homologation process. Also the homologation needs to be conducted by a registered OEM, which means a battery manufacturer cannot homologate their own product. Though, the battery manufacturer can test the battery according to the GB and GB/T standards and the resulting test certificate can be used for the full vehicle homologation by the OEM. The whole vehicle must achieve CCC certification, a process managed by the CQC, CCIC and CCAP and which requires the registration of the battery with the MIIT.



04 Other major automotive markets

Other major global automotive markets that are signatories to the World Forum's Agreement include South Korea (also known as the Republic of Korea) and Thailand, both of which apply the technical requirements of UNECE Regulations to the review and approval of xEV batteries and battery systems.

South Korea, which formerly relied on self-certification for automotive components, adopted a more rigorous regulatory process in 2011 to help ensure component safety. As a result, the country now requires OEMs of xEV batteries and battery systems to test their products to verify compliance with the battery pack testing requirements of the relevant Korean Motor Vehicle Safety Standard (KMVSS). The resulting test report is then used to support the certification of the xEV by Korea Transportation Safety Authority (KOTSA).

Similarly, Thailand had adopted a type approval process for the review and approval of automotive components. The country's Department of Land Transport (DLT) has adopted UNECE Regulations as the standards that manufacturers and importers must meet to order to obtain the DLT Automotive Certification T-Mark, which is required to legally market and sell automotive components in Thailand. However, as of this writing, no timetable has been established for mandatory compliance with this requirement.

Other major global automotive markets that are signatories to the World Forum's Agreement include South Korea and Thailand.

How TÜV SÜD can support xEV battery system developers and designers in achieving global market access

TÜV SÜD is actively supporting the efforts of OEMs of xEV batteries and battery systems to validate the safety and performance of their products, and to successfully navigate the homologation process in major markets around the world. The scope of our services includes:

- Technical advice
- Documentation review
- Preparation of technical reports
- Type approval testing and certification for most major markets
- Complete homologation support

With more than 150 years' experience as testing and certification company and decades of experience working with leading manufacturers and suppliers in the automotive industry, TÜV SÜD is also globally recognized for its advanced battery testing capabilities, and is the only company with a worldwide network of battery testing laboratories. Our laboratories throughout North America, Germany, China, Japan, Korea and Thailand offer a full range of xEV battery testing services, including various tests to assess battery safety and integrity, performance and durability considerations, and environmental and lifecycle concerns. We can also develop and conduct customized testing plans to meet unique specifications or requirements.

Summary and Conclusion

Assessing the safety and performance of rechargeable batteries and battery systems is a critical element in the design and development of xEVs and xEV technologies. International standards play an essential role in this process, and meeting the requirements of these standards can help improve battery safety while streamlining the acceptance by regulatory authorities. But OEMs of xEV batteries and battery systems must also anticipate and be prepared to deal with complexities and challenges of diverse homologation issues in key automotive markets. By working proactively with knowledgeable third-party organization to address these issues in advance, OEMs can move forward more efficiently and effectively in achieving faster global access for their products.

OEMs of xEV batteries and battery systems must anticipate and be prepared to deal with complexities and challenges of diverse homologation issues in key automotive markets.

OEMs of xEV batteries and battery systems must anticipate and be prepared to deal with complexities and challenges of diverse homologation issues in key automotive markets.

GLOSSARY OF ACRONYMS

ACEA – European Automobile Manufacturers' Association
BEV – Batterx Electric Vehicle
CCAP – China Certification Center for Automotive products
CCC – China Compulsory Certificate
CCIC – China Certification and Inspection Group
CMVSS – Canadian Motor Vehicle Safety Standards
CQC – China Quality Control
DLT – Department of Land Transport
FMVSS – Federal Motor Vehicle Safety Standards
GB – Guo Biao (Pingyin – National Standard)
GB/T – Guo Biao/Tuijian (Pingyin – National Standard / Recommendation)
GTR – Global Technical Regulation
IEA – International Energy Agency
KMVSS – Korean Motor Vehicle Safety Standard
KOTSA – Korea's Transportation Safety Authority
MIIT – Ministry of Industry and Information Technology
NEV – New Energy Vehicle
NHTSA – National Highway Transportation and Safety Administration
OEM – Original Equipment Manufacturer
REESS – Rechargeable energy storage systems
UNECE – United Nations Economic Commission for Europe
VSTD – Vehicle Safety Testing Directions
xEV – Electrified Vehicles with different drivetrains (x as placeholder)

FOOTNOTES

[1] "As the Covid-19 crisis hammers the auto industry, electric cars remain a bright spot," posting to the website of the International Energy Agency, 18 May 2020. Available at https://www.iea.org/commentaries/as-the-covid-19-crisis-hammers-the-auto-industry-electric-cars-remain-a-bright-spot (as of 13 July 2020).
[2] Data cited in "Europe's Demand for Electric Cars May Get a Jolt From COVID-19 Response," posting to the website of GTM, Greentech Media, July 3, 2020. Available at https://www.greentechmedia.com/articles/read/covid-19-response-to-accelerate-european-ev-demand (as of 13 July 2020).
[3] "The electric car revolution will require us to build better batteries," Business Perspective posted to the website of CNN, August 14, 2019. Available at https://www.cnn.com/2019/08/14/perspectives/batteries-lithium-ion-innovation/index.html (as of 13 July 2020).
[4] "UN Transport Agreements and Conventions," from the website of the United Nations Economic Commission for Europe. Available at http://www.unece.org/trans/maps/un-transport-agreements-and-conventions-18.html (as of 13 July 2020).
[5] "Regulation (EU) 2018/595 of the European Parliament and of the Council of 30 May 2018 on the approval and market surveillance of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles, amending Regulations (EC) No 715/5007 and (EC) No 595/2009 and repealing Directive 2007/46/EC." Available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32018R0858 (as of 13 July 2020).
[6] See Endnote #5
[7] "World Forum for Harmonization of Vehicle Regulations" from the wikipedia.com website. Available at https://en.wikipedia.org/wiki/World_Forum_for_Harmonization_of_Vehicle_Regulations (as of 08 December 2020).

Find out more about TÜV SÜD's xEV battery testing services

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Add value. Inspire trust.
TÜV SÜD is a trusted partner of choice for safety, security and sustainability solutions. It specialises in testing, certification, auditing and advisory services. Since 1866, the company has remained committed to its purpose of enabling progress by protecting people, the environment and assets from technology-related risks. Through more than 25,000 employees across over 1,000 locations, it adds value to customers and partners by enabling market access and managing risks. By anticipating technological developments and facilitating change, TÜV SÜD inspires trust in a physical and digital world to create a safer and more sustainable future.

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