# Status of safety regulations on Electric Vehicles

**December 4th, 2019**

JAPAN AUTOMOBILE STANDARDS INTERNATIONALIZATION CENTER

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1. Potential Risks and UN Safety Regulations

2. Basic Safety Requirements

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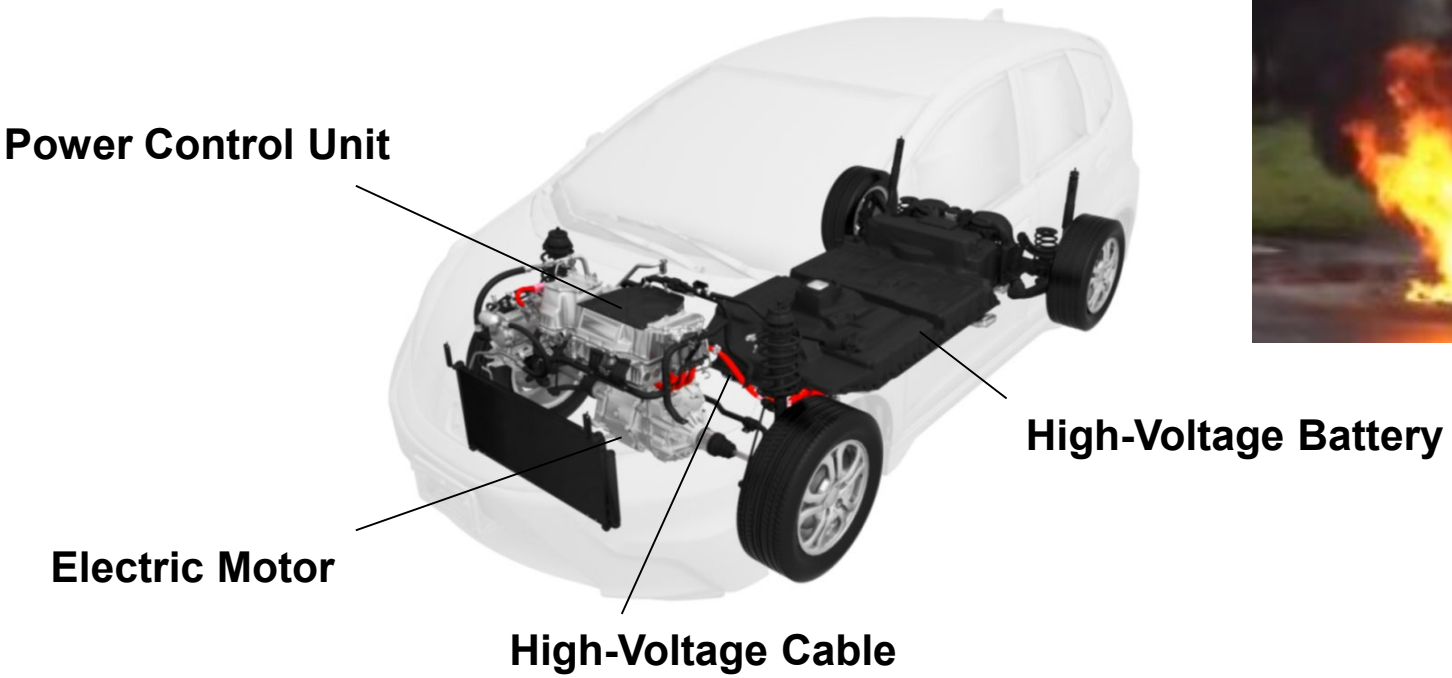
# 1. Potential Risks and UN Safety Regulations

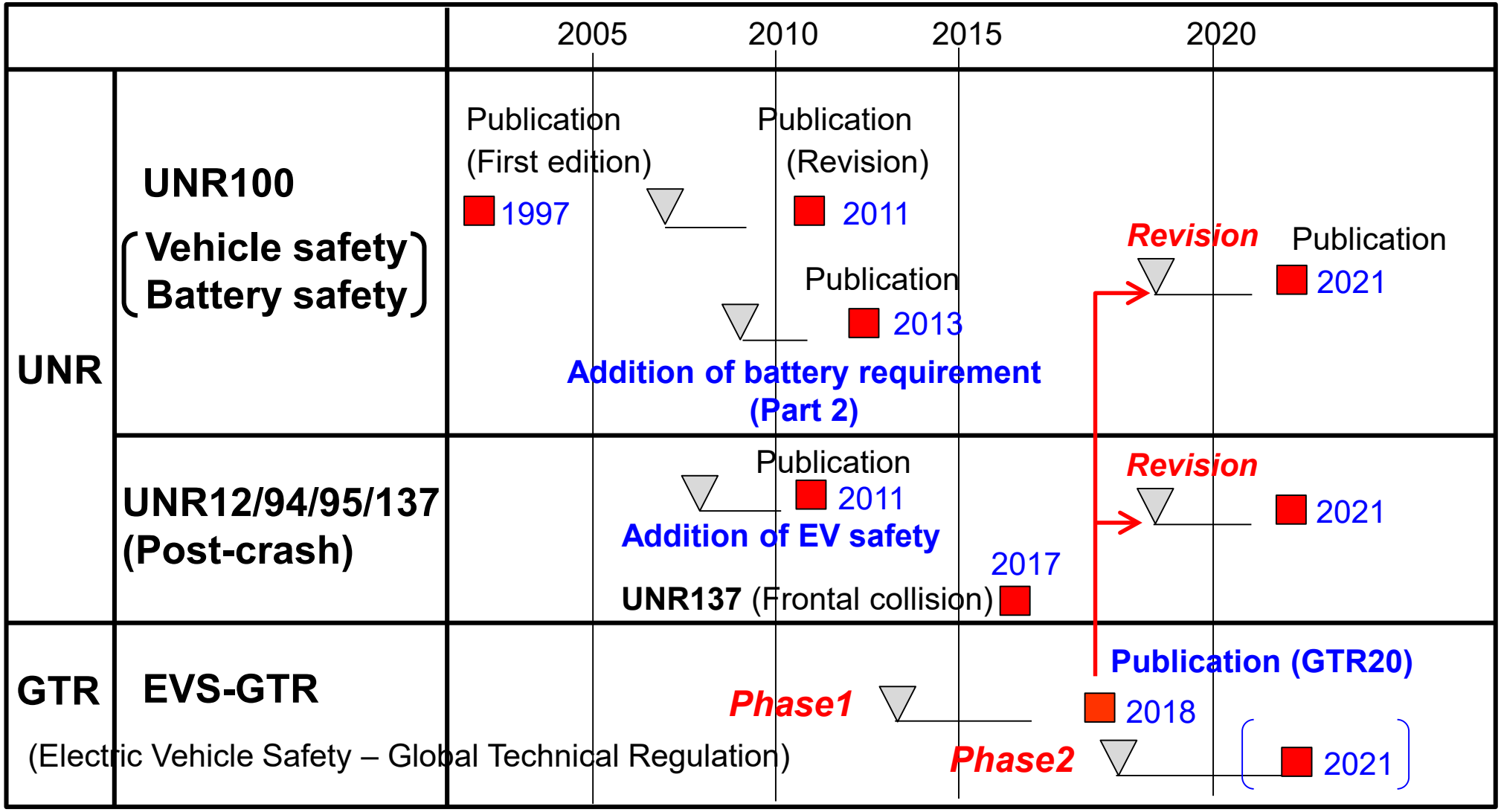
## *Potential risk of electrical power train in EV*

- **Electric shock by touching high voltage buses**
- **Overheat by excessive current**
- **Risks related to unique components**
- **Risks related to unique characteristics and operation**



# 1. Potential Risks and UN Safety Regulations

***History and Future Plan for Rulemaking at UN for EV Safety***



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# 2. Safety Requirements in UN Regulations

## 1, Electric Shock Protection

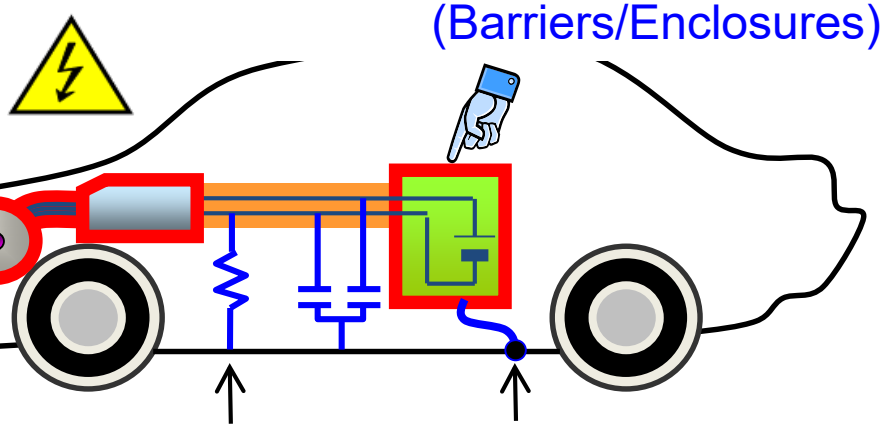
*High Voltage Safety Requirements in In-Use Situation*

*1, Electric Shock Protection in Normal Situation*

**Identification of high voltage**

- High Voltage Symbol
- Orange Cable

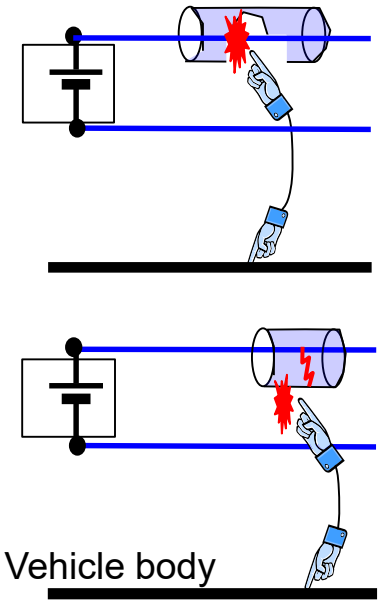
**Protection against direct contact**
(Barriers/Enclosures)



**Isolation Resistance**

**Protection against indirect contact**

Single-fault conditions




*2, Protection in Single-fault conditions*

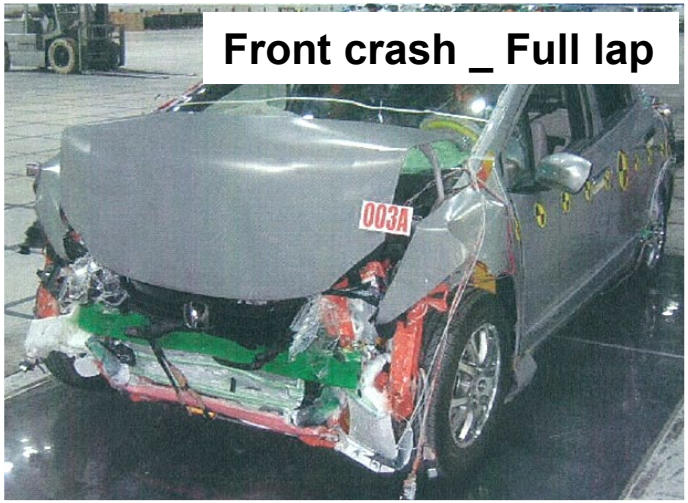
# 2. Basic Safety Requirements

## *2, Post-crash Safety*

Electric safety requirements shall be evaluated and met after crash test.

***Specifications in UNRs***

- ◆ Protection against electrical shock (High voltage safety)
- ◆ Electrolyte spillage
  - Inside passenger compartment : No leakage
  - Outside : Not more than 7% (maximum 5L)
- ◆ Rechargeable energy storage system retention
  - To remain inside REESS boundaries
  - Not to enter into the passenger compartment



# 2. Basic Safety Requirements

## *3, Battery Safety*

| | Item | | Purpose |
|---|---|---|---|
| 1 | Vibration | | Environmental and Mechanical Safety |
| 2 | Thermal shock and cycling | | |
| 3 | Mechanical impact | Mechanical Shock | Safety at Vehicle Crash |
| 4 | | Mechanical integrity | |
| 5 | Fire resistance | | Safety at Vehicle Fire Situation |
| 6 | External short circuit protection | | Control System Safety |
| 7 | Overcharge protection | | |
| 8 | Over-discharge protection | | |
| 9 | Over-temperature protection | | |
| 10 | Emission | | Hydrogen Safety |

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# 3. EVS-GTR Overview

**EVS: Electric Vehicle Safety**
**GTR: Global Technical Regulation (Uniform global standards)**

■ **EVS-GTR** are the uniform global standards related to electric vehicle safety

Electric vehicle (EV): **BEV**, **HEV**, **PHEV**, **FCV**, etc.

Safety: **Electric Shock Protection, Battery Safety, Operational Safety, Post-Crash Safety** etc.

■ Main requirements

< **Phase** 1 >

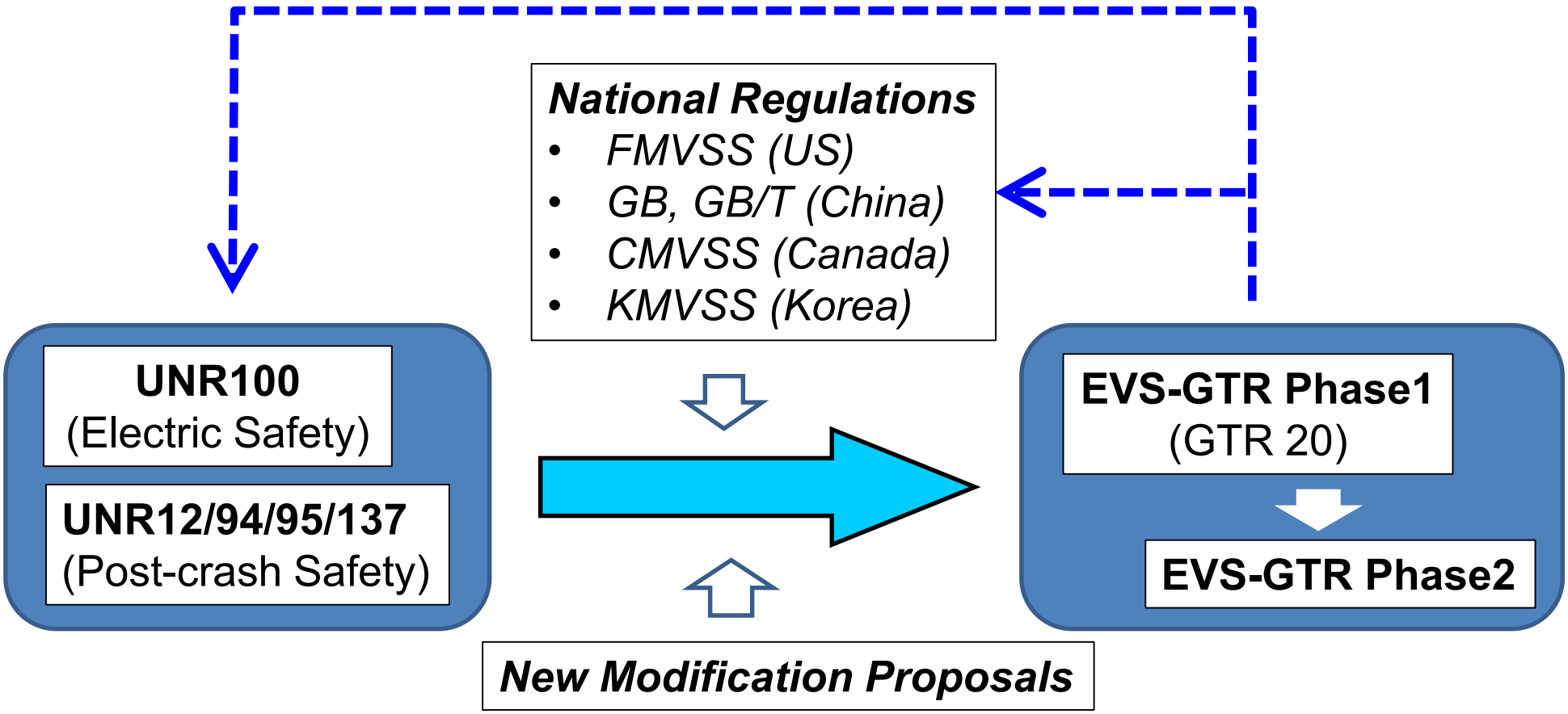
- **Electric safety**
  Electric shock protection, Post-crash safety, Operational safety, REESS installation, etc.
- **Battery safety**
  Battery test requirements (Thermal shock, Vibration, External short circuit, Overcharge, Over-discharge, Overheating, Over current, low temperature, Gas management, Thermal propagation, Fire resistance, post-crash, etc.)

< **Phase 2** >

- Remaining issues from Phase 1
  **Thermal propagation**, **Water immersion**, **Vibration profile**, **Gas toxicity**, **high voltage safety**, Charging safety, Post-accident rescue safety, Requirements L6 / L7, over currents (new items)

# 3. EVS-GTR Overview

GTR will be incorporated in UNR and National regulations.



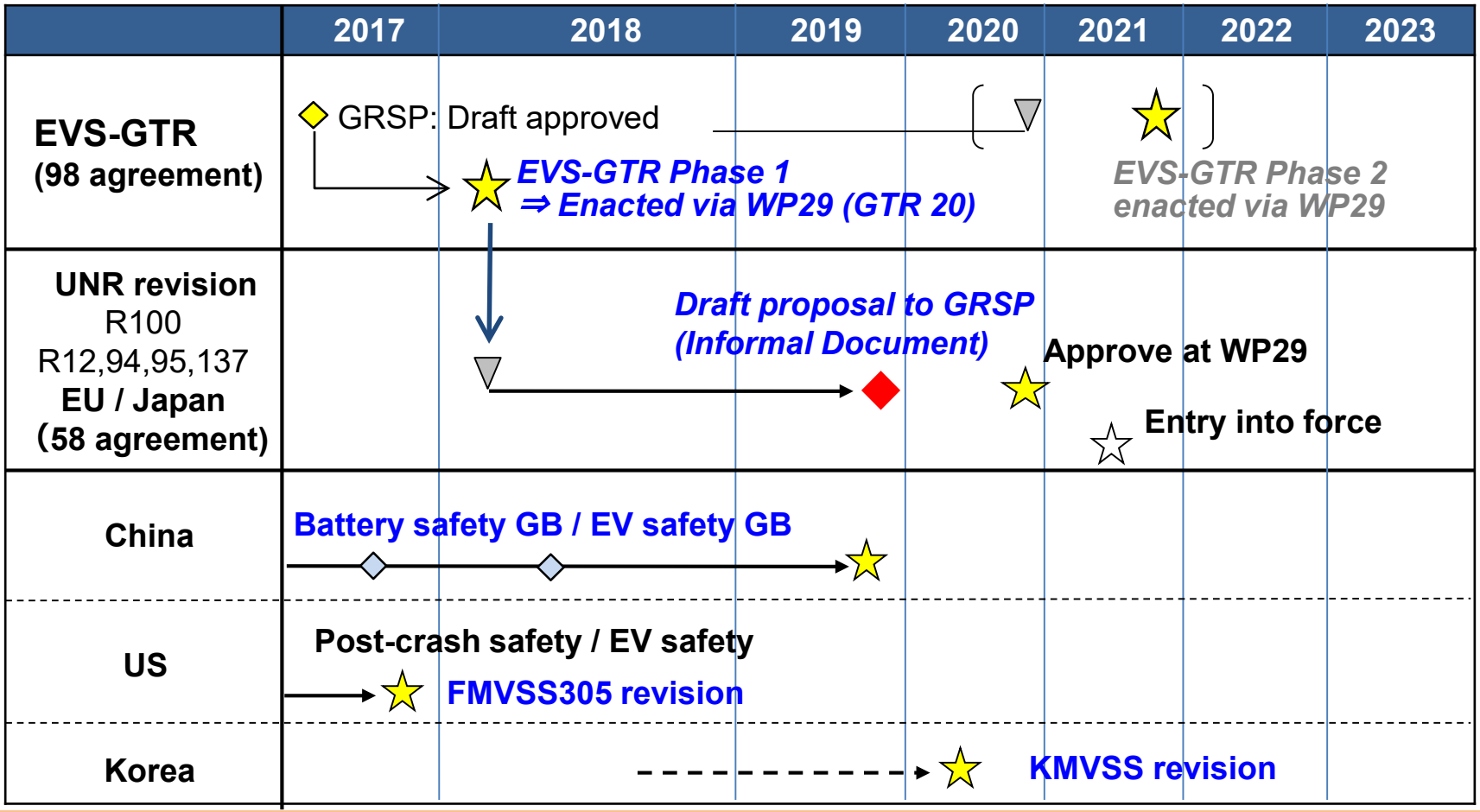
# 3. EVS-GTR Overview

## ■ EVS-GTR (Phase1) status

- Adopted at WP29 in March 2018 and enacted as GTR No.20.
- Currently, activities are being carried out to lead to its adoption in the laws / regulations of each country.

## ■ EVS-GTR (Phase2) status

- Debate began at an informal meeting in March 2018. The aim is to take effect in 2021.



# 3. EVS-GTR Overview

## Requirements for Electric Safety and Post-crash Safety

● : New item ◎ : Partly modified item ○ : No-change

| Category | | Items | | UNR100 | UNR 12/94/95/137 | EVS-GTR Phase 1 |
|---|---|---|---|---|---|---|
| Vehicle safety | Electric shock protection | Direct contact protection | | ○ | | ○ |
| | | | Service disconnect | ○ | | ○ |
| | | | Marking | ○ | | ◎ |
| | | Indirect contact protection | | ○ | | ◎ |
| | | Isolation resistance | | ○ | | ○ |
| | | **Protection against water effect** | | | | ● |
| | Operational safety | | | ○ | | ○ |
| Post-crash safety | Electric shock protection (Options) | Low voltage | | | ○ | ◎ |
| | | Low energy | | | ○ | ◎ |
| | | Physical protection | | | ○ | ◎ |
| | | Isolation resistance | | | ○ | ○ |
| | Electrolyte leakage | | | | ○ | ◎ |
| | Battery retention | | | | ○ | ○ |
| | **Fire protection** | | | | | ● |

# 3. EVS-GTR Overview

## Requirements for Battery Safety

● : New item　◎ : Partly modified item　○ : No-change

| Items | | UNR100 | EVS-GTR Phase1 |
|---|---|---|---|
| Vibration | | ○ | ○ |
| Thermal shock | | ○ | ○ |
| Fire resistance | | ○ | ◎ |
| External short circuit | | ○ | ○ |
| Over charge protection | | ○ | ◎ |
| Over-discharge protection | | ○ | ◎ |
| Over-temperature protection | | ○ | ◎ |
| **Over-current protection** | | | ● |
| **Low temperature characteristics** | | | ● |
| Hydrogen emission | | ○ | ○ |
| Crash | Mechanical impact | ○ | ○ |
| | Mechanical integrity | ○ | ○ |
| **Thermal propagation** | | | ● |
| **Warning requirements** | | | ● |

# 3. EVS-GTR Overview

***Major Discussion Items in EVS-GTR Phase 2***

| Item | Status |
|---|---|
| **Thermal propagation** | ***Safety requirements for single cell thermal runaway incidents***<br>Each country is actively conducting research. Numerous presentations have been given, but a direction has not been determined yet. |
| **Saltwater immersion** | ***Safety requirements for battery immersion in case of flooding***<br>The discussion point is whether GTR needs to cover incidents due to natural disasters or not. |
| **REESS vibration** | ***Review of current battery vibration test profile (sine sweep)***<br>The profile modification based on vehicle rough road driving data has been proposed and discussed. |
| **High voltage safety** | ***Proposal of adding and revising requirements***<br>Isolation resistance measurement option, limitation of capacitive energy, isolation monitoring system evaluation method are discussed. |
| **Gas toxicity** | ***Safety requirements for gases generated from battery***<br>The research for the identification of toxic gases and the development of gas concentration measurement method are being conducted. |

Next meeting (the 17th Informal Working Group Meeting) : Dec. 3-5 @ Berlin)

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# 4. Summary

- At WP29, UN R100 has been established for EV safety.
  (00- in1997 and -01 series revision in 2011, 0-02 series 2013)

- EVS-GTR Phase 1 has been published as GTR 20 in March, 2018. Related UN regulations i.e. UN R100 and other national regulations will be revised to incorporate specifications in GTR 20. International harmonization among national and regional regulations has been promoted.

- EVS-GTR Phase 2 is under discussion to solve remaining issues from Phase 1. Controversial discussion continues to make consensus among the 1998 agreement countries.

# Thank you very much for your attention.