Safety Standards and Testing - Overview

Crash Safety Legislation: Europe, USA and other countries
Legislation Types

• International
  – ECE (UN Economic Commission for Europe)
  – EU (EG-Directive)

• National
  – Canada/USA (CMVSS/FMVSS)
  – Australia (ADR)
  – Japan
  – India (AIS)

• Provincial / State
  – Canada
  – USA
  – Australia
Overview

• Legislation Types
  – International Harmonized regulations
  – How everything started
  – Agreements administered by WP.29
  – 1958 Agreement
  – 1998 Agreement
  – European Regulatory system
International harmonized regulations

• Developed within United Nations Economic Commission for Europe UNECE WP.29 for international harmonization purpose
  – 1958 agreement "Agreement concerning the adoption of uniform technical prescriptions for wheeled vehicles, equipment and parts which can be fitted and/or be used on wheeled vehicles and the conditions for reciprocal recognition of approvals granted on the basis of these prescriptions"
  – 1995 revision: including also non ECE countries
  – 1998 agreement
• National decisions to put in place new ECE regulations
  – Through EC DG Enterprise
• For Europe EEVC coordinates pre-regulatory researches
WP.29: How everything started

• Created in 1952 as a Working Party of experts on technical requirements of vehicles
• 1956 Rome Agreement: first step to harmonize vehicle regulations
• The 1958 Agreement (20 June 1959) on uniform conditions of approval and mutual recognition of approvals of vehicles, components and parts
  – Active and passive safety
  – Protection of the environment
  – Anti-theft protection
WP.29: World Forum for Harmonization of Vehicle Regulations

- The 1958 Agreement
- The 1997 Agreement (27 January 2001) on periodical technical inspections
- The 1998 Global (Parallel) Agreement (25 August 2000) on global technical regulations
- In 2000 WP.29 became the World Forum for Harmonization of Vehicle Regulations that is a working party of the United Nations Economic Commission for Europe (UNECE)
Participation in WP.29

• Open to all UN Member States and Regional Economic Integration Organizations (EC)
  – Governments and Technical services
• Inter-Governmental Organizations
• Non-Governmental Organizations
  – ISO, Road Users, Vehicle and spare parts
  – Manufacturers, EEVC, Consumers ...
Agreements administered by WP.29 (1)

• Concluded under UNECE auspices
• International law
• Elaborated by consensus
• Main legal text, Technical Annexes
• Amended as the needs arise
• The Depositary is the United Nations Secretary-General (UN S-G)
• Follow well-established UN legal procedures
Agreements administered by WP.29 (1)

- Open to all UN Member States and **Regional Economic Integration Organization (REIO)**
- Many non-ECE States are already Parties
- To become a **Contracting Party (CP), deposit an instrument with the S-G**
- No accession fee
The 1958 Agreement

Objectives:
Increase vehicle and road safety, vehicle environmental performance and facilitate vehicles’ trade through:

- Uniform prescriptions for vehicles and their parts (UNECE Regulations annexed to the Agreement)
- Type approval of vehicles and their parts
- Reciprocal recognition of approvals granted
1958 Agreement

Key Provisions (1)

• Regulations are a part of the Agreement. They are international law
• CPs are free to be bound by all, some or no
• Regulation
• Regulations apply to vehicles and their parts
1958 Agreement

Key Provisions (2)
Regulations to include:
• technical prescriptions and alternative
• requirements as appropriate
• test methods and conditions for granting type Approvals
• type approvals and their mutual recognition, Marketing
• prescriptions for conformity of production
1958 Agreement

Key Provisions (3)

• Tests conducted by approved technical services
• Designated Administrative Departments grant type-approvals, if tests are passed
• Mutual recognition for CPs applying a Regulation
• Open to self certification procedures, but focused on type approval
1958 Agreement
EU, ECE & USA

Most notable non-signatory to the 1958 Agreement is the United States, which has its own *Federal Motor Vehicle Safety Standards (FMVSS)* and *does not* recognize ECE approvals.

ECE vehicles and components therefore cannot be imported or exported between the U.S. and most of the rest of the world without appropriate modifications.
The 1998 Agreement

Objectives:
Improve global safety, decrease environmental pollution and consumption of energy and improve anti-theft performance of vehicles and related components and equipment through:

– Establishing global technical regulations (GTRs) in a Global Registry based on UNECE Regulations or on national regulations listed in a Compendium of candidates GTR harmonizing them at the highest level
The 1998 Agreement

Key provisions (1)
• gtrs to include field of application, technical prescriptions, alternative requirements as appropriate, test methods
• No certification procedure (type approval or self certification)
• No reciprocal recognition
• Introduce two main sub-sets
  – Compendium of Candidate Global technical Regulations
  – Registry of global technical regulations
The 1998 Agreement

Key provisions (2)

• Adoption of gtrs by consensus of the Executive Committee (AC.3) of the Agreement present and voting

• gtrs may specify alternative non-global levels of stringency or performance and appropriate test procedures when needed to facilitate the regulatory activities of developing countries
The 1998 Agreement

Key provisions (3)

• CPs voting in favour shall initiate internal procedures to incorporate gtr into their national laws – level of Stringency

• A CP may decide not to adopt a gtr informing the S-G

• Periodical reports to the S-G regarding the procedure for adoption of the gtr

• A CP not adopting a gtr may decide to accept products in compliance with the prescriptions of the Gtr

• A CP may introduce an amended gtr as national law
The 1998 Agreement

Compendium of Candidates

- Catalogue of regulations that are candidates for harmonization or adoption as gtrs
- UNECE Regulations of the 1958 Agreement are Candidates
- Any CP may propose any technical regulation for its listing in the Compendium
- Voting in AC.3: At least 1/3 of the CPs presenting and voting, with, in addition, the positive vote of USA, EC and Japan
- Now: 123 UNECE Regulations + 9 technical regulations
The 1998 Agreement

Global Registry (1)

• The Registry contains all adopted gtrs

• A gtr can be established through harmonization of existing regulations, on the basis of a regulation listed in the Compendium, or of a UNECE Regulation under the 1958 Agreement

• A gtr can also be established concerning elements of performance or design characteristics not addressed by technical regulations in the Compendium or by UNECE Regulations
The 1998 Agreement
European Regulatory System

**ECE (Geneva)**
- ECE - Economic Commission for Europe
- WP 29 Geneva
- Regulations - voluntary
- All European countries plus others (US, Russia, Japan...)
- Approval of > 2/3 of parties
- About 130 regulations

**EC (Brussels)**
- EC - European Commission
- Brussels
- Directives - mandatory for member states
- All members states
- Involvement of European Parliament
- All have agree (consensus)
Crash Regulations

- **Frontal collision protection**
- **Side impact protection**
- **Rear impacts (Fuel leakage)**
- **Roof strength**
- Component and system tests
  - **Pedestrian**
  - **Child safety**
Frontal collision EU, 96/79/EC

- New cars 1/10 -98
- All new registrations 1/10 -03

**General:**
- The directive applies to new cars in category M1 with a Gross Vehicle Weight Rating (GVWR) less or equal to 2500kg.
- New tests with a complete vehicle might be required if there are changes made resulting in an increase of the weight with more than 8% on a vehicle approved according to this directive or if there are structural changes affecting the collision performance.
- Vehicles approved in accordance to this directive are excluded from the 74/297/EEC steering wheel test.
Frontal collision EU, 96/79/EC

V = 56 km/h
Overview

Crash

Frontal collision EU, 96/79/EC

Test method:
• 40 % ± 20 mm overlap in 56 km/h.
• Deformable barrier (AL honeycomb).
• Two Hybrid III dummies in the front seats (injury criteria).
• The vehicle should be a representative production vehicle, the choice of left or right-hand drive is made together with the issuing authority.
• No door is allowed to open during test and the front doors may not be jammed.
• It should be possible to open at least one door per passenger row without tools after crash and the maximum force needed to unbuckle the crash test dummy is 60 N. Further on, the dummy must be removable without adjusting the seats.
• The fuel leakage may not exceed 30 g/min.
Frontal collision EU, 96/79/EC

- Injury criteria
- Head: HPC (Head Performance Criterion), less or equal to 1000.
- Head acceleration (3 ms): Less or equal to 80 g.
- Chest: Thorax Compression Criterion (ThCC): 50 mm.
- Soft tissue criterion (VC), less or equal to 1.0 m/s.
- Neck: Neck bending moment, less or equal to 57 Nm.
- Neck: NIC (Neck Injury Criterion) may not exceed following:
  - Neck Shear force: 3.1 - 1.1 kN dependently to time duration
  - Neck Tension Force: 3.3 - 1.1 kN dependently to time duration
Frontal collision ECE R94

Tension

Shear

Graphs from K U Schmidt (2005)
Frontal collision EU, 96/79/EC

Injury criteria
- Thigh-bone: Femur Force Criterion (FFC) dependently to duration of the pulse: 9 - 7.8 kN
- Shinbone: Tibia Compression Force Criterion (TCFC), less or equal to 8 kN
- Tibia Index: Less or equal to 1.3 (top and bottom).
- Movement of the sliding knee joints: Less or equal to 15 mm.
- Steering wheel intrusion: Less or equal to 80 mm upwards/vertical and less
  - or equal to 100 mm rearwards/horizontal.

The EU Commission consider to improve:
- collision velocity
- injury criteria
- new requirements regarding floor intrusion
Frontal collision USA, (FMVSS 208)

Overview

Crash

Full frontal stiff barrier
0 degr, +/-30 degrees

Present FMVSS 208 (depowered air bags)
Belted test, speed 30 mph
Frontal collision USA, (FMVSS 208)

Present FMVSS 208 (depowered air bags)

- 30 mph 0° ± 30° full frontal collision belted/not belted into barrier
  - Sled testing with unbelted dummies
    - Pulse corresponds to appr. 22 mph barrier test
    - Complete vehicle on sled
  - Barrier test with belted dummies
    - 30 mph (0 degr, +- 30 degr.)
    - 2 hybrid III dummies in front seat (one female 5%%)
  - Barrier in accordance with SAE J850

- Injury criteria:
  - Head (HIC) max 700
  - Chest accélération max 60 g
  - Thigh force max 10 kN
  - Thorax compression max 3” = 76 mm
  - Neck injury criteria: flexion bending, extension bending,
    axial tension, axial compression, fore-aft-shear.

- The Hybrid III dummy is compulsory as from 1/9 -97
Frontal collision USA, (FMVSS 208) Advanced Airbag Final Rule

- **Safety problem:**
  - Approximately 200 occupants killed by air bags
  - Mainly children and small female drivers
  - Depowered air bags only temporary solution
- **Final Rule published May 2000**
- **Effective dates (phase-in) first phase:**
  - First phase starting Sept 1, 2003
  - Second phase starting 2007
- **Increase belted test speed to 35 mph**

**Goals:**
- Improved occupant protection in high speed impacts, belted and unbelted occupants
- Minimize risk to infants, children and other occupants from injuries caused by air bags
## Overview

### Australia

ADR 69: *from 1/1-96, as belted FMVSS 208*, from 1/1-98 only H III dummy.

ADR 73 proposal: Frontal collision according to the new 96/79/EC, i.e. 56 km/h, 40% offset. 1/1-99 New Types, 1/1-04 all registrations. Discussions about possibly raising the collision speed further.

### Bulgaria

ECE R33.

### Canada

CMVSS 208

*Economic Commission Europe (ECE)*

ECE R.29.01

ECE R.33

ECE R.34.01

ECE R.94 (will be harmonized with corresponding EU directives, 96/79/EC)
Frontal collision - requirements

**European Union**
- 96/79/EC from 1/10 -98 New Types from 1/10 -03 All registrations (56 km/h, 40% offset)
- Discussions are held about changing the barrier, test speed, injury criteria in the future.

**Gulf States**
- GS 36 FMVSS 301 (No roll-over)

**Japan**
- TRIAS 47 from 1/4 -99, all imported cars must pass, belted dummies as FMVSS 208
- There are demands of fuel leakage test according to FMVSS 301.

**Korea**
- Article 102, same as FMVSS 208 (belted)

**Poland**
- ECE R.29

**Rumania**
- ECE R.29
- ECE R.33
- ECE R.34
# Frontal collision - requirements

<table>
<thead>
<tr>
<th>Country</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russia</td>
<td>ECE R.33</td>
</tr>
<tr>
<td>Slovenia</td>
<td>ECE R.29</td>
</tr>
<tr>
<td>Ukraine</td>
<td>ECE R.33</td>
</tr>
<tr>
<td>USA</td>
<td>FMVSS 204 <em>(Steering Wheel Rearward Displacement)</em></td>
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<td></td>
<td>FMVSS 208</td>
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<tr>
<td></td>
<td>FMVSS 212 <em>(Windshield Zone Intrusion)</em></td>
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<tr>
<td></td>
<td>FMVSS 219 <em>(Windshield Intrusion)</em></td>
</tr>
<tr>
<td></td>
<td>FMVSS 301 <em>(Fuel Systems Integrity)</em></td>
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<tr>
<td>India</td>
<td>AIS 098 – in compliance with ECE R94 and FMVSS 208</td>
</tr>
</tbody>
</table>
Side collision EU(96/27/EC–ECE R9501)

New cars 1/10 -98
All new registrations 1/10 -98

General:
• The directive comprises cars and light trucks
• New types are defined as vehicles without approval before 1/10 - 98 in at least two of the following EU directives: 70/387/EEC, 74/483/EEC and 76/115/EEC. These are in turn: “Door lock”, “Exterior” and “Belt anchorage”
• Modifications on a vehicle approved according to this directive, which might affect the performance of a side collision, must be reported to the authority that decides about possible new tests.
• An increase in weight with more than 8 % might result in new tests.
Side collision EU(96/27/EC–ECE R9501)

Test method:
- A movable deformable barrier (MBD) weight of 950 ± 20 kg
- Ground clearance: 300 ± 5 mm
- Velocity: 50 ± 1 km/h
- EUROSID crash test dummy
Side collision EU(96/27/EC–ECE R9501)

Injury criteria:

- Head: HPC (Head Performance Criterion), less or equal to 1000
- Chest: RDC (Rib Deflection), less or equal to 42 mm
- Soft tissue criterion (VC), less or equal to 1.0 m/s
- (VC shall be measured but was not a pass/fail criteria until after 1/10 -00)
- Pelvis: PSPF (Pubic Symphysis Peak Force), less or equal to 6 kN
- Abdomen: APF (Abdominal Peak Force), less or equal to 2.5 kN internal (4.5 kN external)
- The doors should remain closed during the crash
- It should be possible to remove the crash test dummy after crash
- The fuel leakage may not exceed 30 g/min
Side collision USA (FMVSS 214)

\[ V = 33.5 \text{MPH} \]
Side collision USA (FMVSS 214)

General:

- A movable deformable barrier (MDB) strikes the vehicle in the side at 33.5 mph. The barrier strikes the vehicle oblique to simulate a speed of 30 mph for the striking vehicle and 15 mph for the struck vehicle.
- SID crash test dummies front and rear in the vehicle on the struck side.

Injury Criteria:
Thorax Trauma Index (TTI*): max. 85 g (4-doors)
max. 90 g (2-doors)

*Average of peak rib and peak lower spine accelerations.
Hip acceleration: max. 130 g

- Doors on the struck side are not allowed to completely separate from the body, remaining doors must stay closed.
Side collision - requirements

**Australia**
ADR 29 *Static part of FMVSS 214*
ADR 72 Proposal to introduce EU’s side collision directives (92/27/EC) or FMVSS 214 dynamic.
1/1 -99 New Types
1/1 -04 All registrations

**Canada**
CMVSS 214 *(static only)*
Discussions are held about introducing a dynamic part, not necessarily in accordance with USA. *Economic Commission Europe (ECE) ECE R.95, will be harmonized with 96/27/EC.*

**European Union** *(EU) 96/27/EC, 50 km/h, 300 mm barrier height*
1/10 -98 New Types
1/10 -03 All registrations
Discussions are held about adjustments of barrier height, collision speed etc.
Side collision - requirements

**Gulf States**  
GS 38, FMVSS 214 (static part)  
Discussions are held about introducing side collision requirements according to the European model.

**India**  
AIS -099, FMVSS 214 (static part)

**Japan**  
From 1/10 -03 TRIAS 47 (for all imported cars)  
according ECE 95-01 side collision directives,

**Korea**  
Article 104 FMVSS 214 (static part)

**USA**  
FMVSS 214, static door intrusion + dynamic barrier test. FMVSS 301, discussions are held about replacing this fuel leakage test with FMVSS 214, i.e. measure fuel leakage at dynamic 214 testing.
Rear collision

- **Argentina**  FMVSS 301, fuel leakage
- **Bulgaria**  ECE R.32
- **Economic Commission Europe**  ECE R.32
  ECE R.34
- **Gulf States**  GS 37, equals FMVSS 301 (no roll-over)
  (ME)
- **Japan**  FMVSS 301
- **Rumania**  ECE R.32
  ECE R.34
- **Russia**  ECE R.32
  ECE R.34
- **Ukraine**  ECE R.32
- **USA**  FMVSS 301
<table>
<thead>
<tr>
<th>Region</th>
<th>Standard</th>
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<tbody>
<tr>
<td>Canada</td>
<td>CMVSS 216</td>
</tr>
<tr>
<td>Gulf States (ME)</td>
<td>GS 39, same as FMVSS 216</td>
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<tr>
<td>Korea</td>
<td>Article 92, same as FMVSS 216</td>
</tr>
<tr>
<td>USA</td>
<td>FMVSS 216</td>
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</tbody>
</table>
Pedestrian protection

- Negotiated Agreement / Envelope Directive:
- Requires new vehicle types to comply by July 1, 2005.
- Vehicle registrations: 80% by 2010
- 90% by 2011
- 100% by 2012
- Regulation in India – AIS 100
# Pedestrian - test condition EEVC-WG17

<table>
<thead>
<tr>
<th>Child Head</th>
<th>Lower Leg</th>
</tr>
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<tbody>
<tr>
<td>Mass of Impactor</td>
<td>Area</td>
</tr>
<tr>
<td>2.5 Kg</td>
<td>Full Bumper Width</td>
</tr>
<tr>
<td>Impact Speed</td>
<td>Impact Speed</td>
</tr>
<tr>
<td>40 km/h</td>
<td>40 km/h</td>
</tr>
<tr>
<td>Impact Angle</td>
<td>Criteria (G)</td>
</tr>
<tr>
<td>50°</td>
<td>150g</td>
</tr>
<tr>
<td>WAD</td>
<td>Criteria (Bending)</td>
</tr>
<tr>
<td>1000-1500 mm</td>
<td>15°</td>
</tr>
<tr>
<td>Criteria</td>
<td>Criteria (Shear)</td>
</tr>
<tr>
<td>HIC &lt;1000</td>
<td>60 mm</td>
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</table>

<table>
<thead>
<tr>
<th>Adult Head</th>
<th>Upper Leg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass of Impactor</td>
<td>Energy</td>
</tr>
<tr>
<td>4.8 Kg</td>
<td>600J</td>
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<tr>
<td>Impact Speed</td>
<td>Criteria (Force)</td>
</tr>
<tr>
<td>40 km/h</td>
<td>5.0kN</td>
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<tr>
<td>Impact Angle</td>
<td>Criteria (Bending Moment)</td>
</tr>
<tr>
<td>65°</td>
<td>300 Nm</td>
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<tr>
<td>WAD</td>
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<tr>
<td>1500-1800 mm</td>
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</tr>
<tr>
<td>Criteria</td>
<td>HIC &lt;1000</td>
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Child Safety Testing

FMVSS 213, ECE R44: sled testing with different dummies