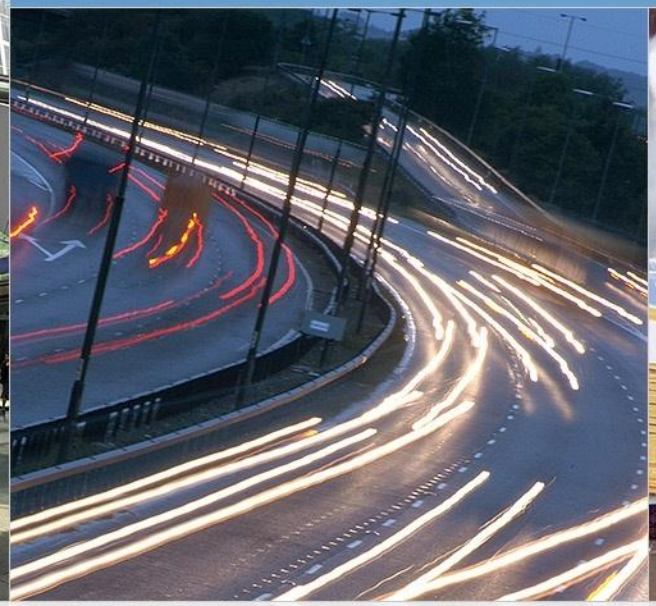

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Automatic triggering of emergency calls

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Introduction

Introduction

- Which vehicles can and should be required to provide automatic emergency calls?
- In which accidents should automatic triggering occur?
- How can type approval ensure that:
  1. Automatic emergency call triggers in accidents as required,
  2. In-vehicle system remains operational after accidents as required?
- Which options do currently exist for full-scale crash testing and component testing?

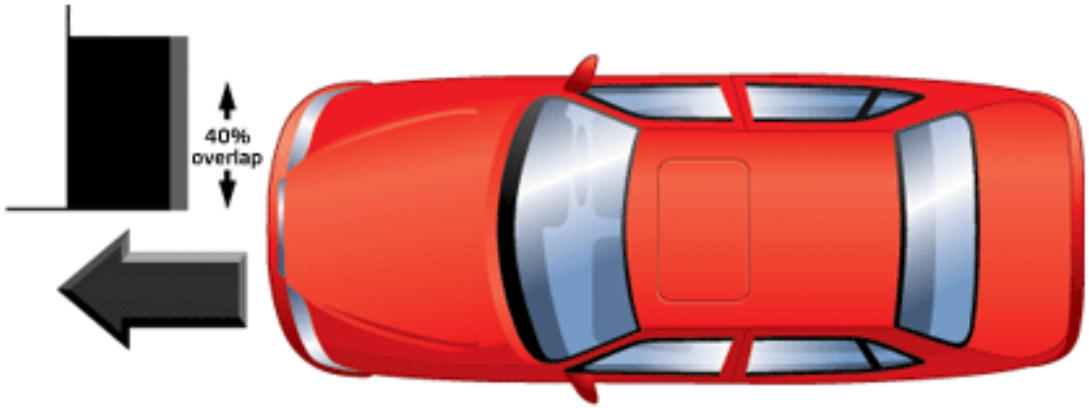
Overview of full-scale crash testing

Overview of crash tests – UN R94

- UN Regulation No. 94 – Frontal collision protection
- Scope: M1 vehicles ≤2,500 kg
- Frontal impact test: Vehicle crashing perpendicularly into object
- Severity related to:
  - impact speed,
  - object struck (rigid or deformable), and
  - level of overlap.

Overview of crash tests – UN R94

- UN R94 frontal impact test (Annex 3):



Based on material from Euro NCAP

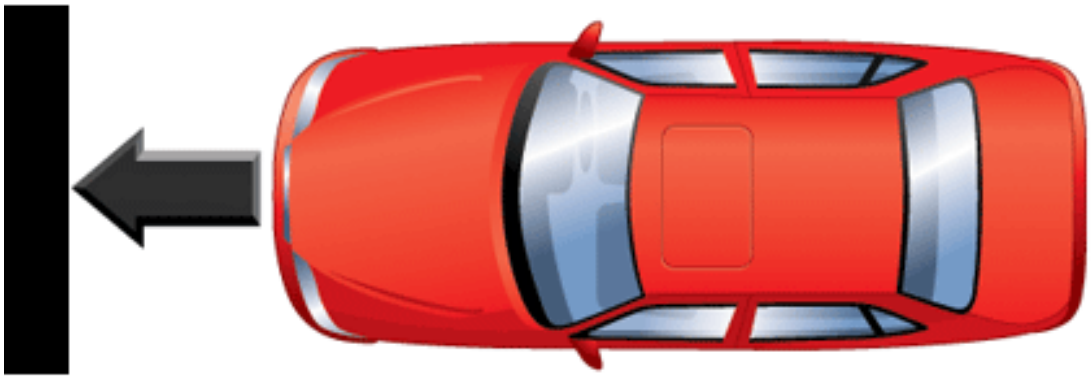
- Impact speed: 56 km/h
- Object struck: Deformable barrier to represent crush characteristics of a typical car
- Overlap: 40% on driver's side
- Designed to challenge vehicle's structural crashworthiness (only one side of is interacting with the barrier and absorbing most of the energy)

Overview of crash tests – Future UN R13x

- UN Regulation No. 13x – Frontal collision protection with focus on the restraint system
- Potential future test: Currently at proposal stage at GRSP Informal Working Group on Frontal Impact (FI)
- Potential scope: M1 vehicles (≤3,500 kg)
- Frontal impact test: Vehicle crashing perpendicularly into object

Overview of crash tests – UN R13x

- Future UN R13x frontal impact test:

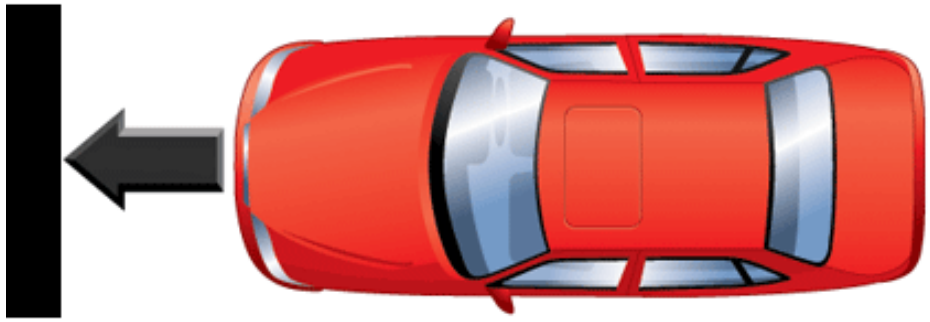


Based on material from Euro NCAP

- Impact speed: 50 km/h
- Object struck: Rigid barrier (concrete covered with plywood)
- Overlap: 100% (full-width)
- Designed to challenge vehicle's restraint system (high decelerations due to full vehicle structure interacting, i.e. higher stiffness)
- Although impact speed lower than in deformable barrier test, mechanical shock will be more severe

Overview of crash tests – UN R12

- UN Regulation No. 12 – Protection against steering mechanism
- Scope: All M1 vehicles and lightweight N1 vehicles (≤1,500 kg)
- Frontal impact test; omitted if UN R94 has been passed



Based on material from Euro NCAP

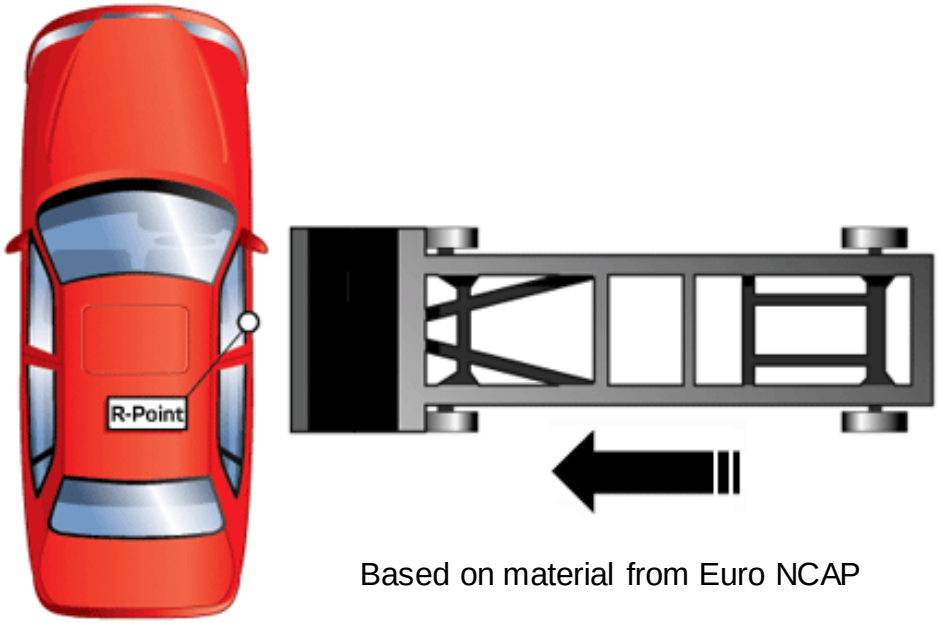
- Impact speed: 48.3 km/h (30 mph)
- Object struck: Rigid barrier (concrete covered with plywood)
- Overlap: 100% (full-width)
- Designed to assess extent of vehicle's steering wheel displacement
- Similar to UN R13x, but different scope and may be omitted if UN R94 passed

Overview of crash tests – UN R95

- UN Regulation No. 95 – Lateral collision protection
- Scope: M1/N1 vehicles with R point height of lowest seat ≤700 mm
- Side impact test: Object crashing perpendicularly into vehicle's side
- Severity related to:
  - impact speed,
  - mass of striking object, and
  - structure of striking object (rigid or deformable).

Overview of crash tests – UN R95

- UN R95 side impact test (Annex 4):



Based on material from Euro NCAP

- Impact speed: 50 km/h
- Striking object mass: 950 kg
- Striking object structure: Mobile deformable barrier to represent crush characteristics of a typical car

Scope: Which vehicles?

Scope of automatic emergency calls

- The core function of AECS is to notify emergency services automatically and rapidly of a potentially injurious accident
- Scope to be defined so as to maximise benefit (maximum number of casualties affected) while keeping costs at a reasonable level
- Effort and cost are at a similar level among all M1 and N1 vehicles as long as they are already equipped with a crash detection system. This can be reasonably expected at least for all vehicles undergoing UN R94 and/or UN R95 full-scale crash testing (although airbags are not mandatory).

Scope of automatic emergency calls

- Different options for scope of automatic triggering:

  A. **All M1/N1** → Maximum scope: Would maximise benefit, but some vehicles are not currently equipped with crash detection sensors

  B. **M1/N1 undergoing both UN R94 and UN R95 crash tests** → Very limited scope: Would capture only M1 vehicles ≤2,500 kg

  C. **M1/N1 undergoing either UN R94, UN R12 or UN R95 crash tests** → Larger scope: Would capture all M1 vehicles and N1 vehicles <1,500 kg or R point height ≤700 mm; but larger vans and pickups still excluded (some of which have gone through Euro NCAP)

  D. **M1/N1 fitted with a crash detection sensor(s)** → Largest scope with reasonable effort: Increases benefit by capturing more N1 vehicles than C (recognising that not all vehicles undergoing UN crash tests are fitted with airbags); similar design effort for all vehicles in scope

Scope of manual emergency calls

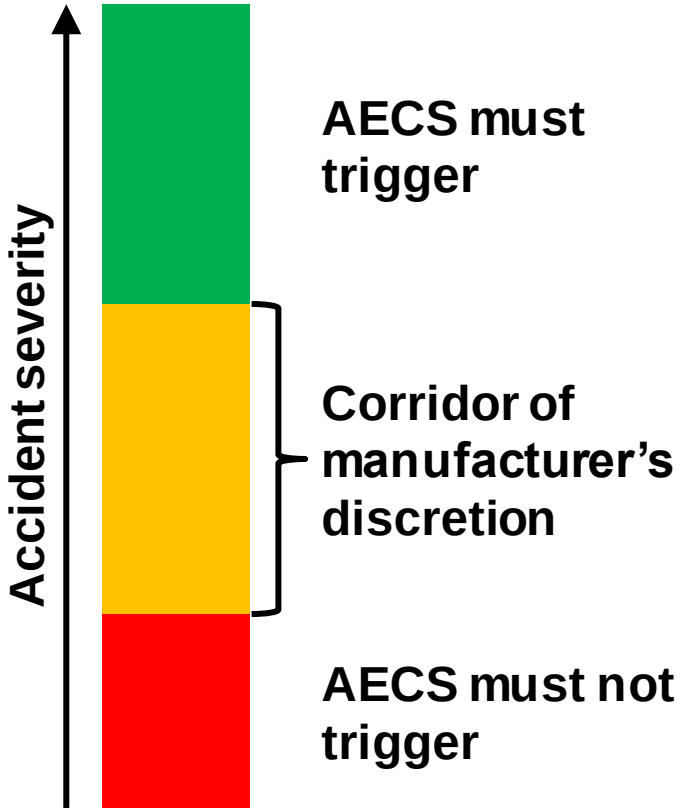
- This “Samaritan mode” is an additional function of AECS that allows notifying emergency services easily when an accident was witnessed
- Might increase benefit during phase-in of AECS into vehicle fleet
- Potential of misunderstanding, abuse and fraudulent calls
- Options for scope of manual triggering:

  A. No manual triggering
  B. Same scope as automatic emergency calls
  C. All M1/N1

Automatic triggering: Which accidents?

Automatic triggering conditions: Which accidents?

- Crash detection algorithms in modern vehicles are complex and highly developed. A triggering algorithm prescribed in legislation would likely be more simplistic and hamper future development → Exact algorithm should be left to manufacturers.
- A corridor for automatic triggering should still be defined in type approval legislation to ensure a certain benefit in all vehicles across the market and a level playing field for manufacturers, and to reduce unnecessary calls.



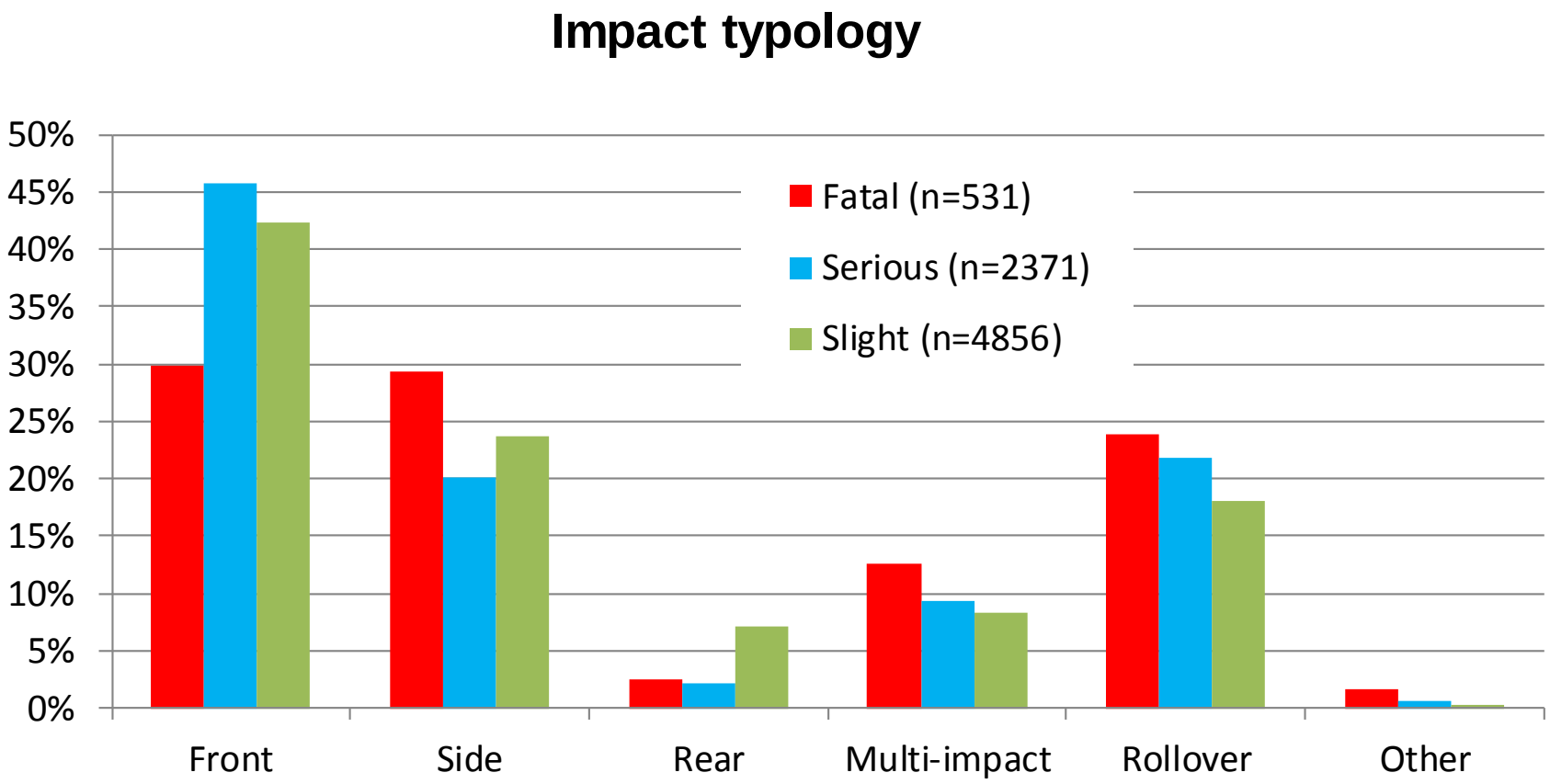
Automatic triggering conditions: Which accidents?

- Defining boundaries of this corridor is complex in reality:
  - Accident severity is not only dependent on deceleration,
  - There are different accident types,
  - Injury risk is not only determined by accident severity (occupant age, position …), etc.
- Accident analysis to investigate different automatic triggering conditions (upper boundary of corridor):
  - Option (1): Accident similar to or more severe than full-scale crash tests UN R94 and/or UN R95
  - Option (2): Airbag deployment, i.e. lower severity than Option (1)

Automatic triggering conditions: Which accidents?

- Estimates of the proportion of casualties that could have been affected, if AECS were fitted in all cars and would trigger according to Option (1) or Option (2)
- In-depth accident data (CCIS database) was scaled to match Great Britain (GB) national casualties
- CCIS data was selected for casualties:
  - in cars registered between 2000 and 2009 and involved in injury accidents between 2000 and 2010;
  - all cars were towed from the scene and examined at their recovery garage; and
  - all car occupants injury data was known.
- Data for the GB national statistics was taken from Reported Road Casualties Great Britain, years 2010, 2011 and 2012 (averaged)
- In total, there were approximately 126,000 injured car users each year in GB

Automatic triggering conditions: Which accidents?



In-depth CCIS data, casualties in cars registered between 2000-2009

Automatic triggering conditions: Which accidents?

Option (1): Similar to or more severe than full-scale crash tests

a) Equivalent (or more severe) than UN R94

b) Equivalent (or more severe) than UN R94 and/or UN R95

	Fatal		Serious		Slight		Total	
Drivers and passengers	834	100%	8496	100%	116610	100%	125945	100%
a) R94 only	212	25%	2167	26%	13831	12%	16210	13%
b) R94 and/or R95	400	48%	3065	36%	22620	19%	26085	21%
Drivers	571	100%	5671	100%	78742	100%	84989	100%
a) R94 only	161	28%	1382	24%	8963	11%	10506	12%
b) R94 and/or R95	295	52%	1995	35%	14754	19%	17044	20%
Passengers	263	100%	2825	100%	37868	100%	40956	100%
a) R94 only	51	19%	785	28%	4868	13%	5704	14%
b) R94 and/or R95	105	40%	1070	38%	7866	21%	9041	22%

- Scaling the CCIS sample, we estimate that automatic triggers would have occurred for approximately:
  - 26% of serious casualties for a) UN R94 only
  - 36% of serious casualties for b) UN R94 and/or UN R95
  - The approach might underestimate, because real-world collisions are complex (pulse hard to predict)
- This would mean between 16,210 and 26,085 automatic triggers in GB (Please note: uninjured not included)

Automatic triggering conditions: Which accidents?

Option (2): Airbag deployment, i.e. lower severity than Option (1)

a) Frontal airbag deploys

b) Any airbag deploys

	Fatal		Serious		Slight		Total	
Drivers and passengers	834	100%	8496	100%	116610	100%	125945	100%
a) Frontal airbag	571	68%	5886	69%	62679	54%	69136	55%
b) Any airbag	644	77%	6364	75%	69397	60%	76405	61%
Drivers	571	100%	5671	100%	78742	100%	84989	100%
a) Frontal airbag	404	71%	3845	68%	41982	53%	46231	54%
b) Any airbag	449	79%	4126	73%	46565	59%	51140	60%
Passengers	263	100%	2825	100%	37868	100%	40956	100%
a) Frontal airbag	167	63%	2041	72%	20697	55%	22905	56%
b) Any airbag	195	74%	2238	79%	22832	60%	25265	62%

- Scaling the CCIS sample, we estimate that automatic triggers would have occurred for between:
  - 55%–61% of all casualties
  - 69%–75% of serious casualties
  - The approach might underestimate, e.g. because not all vehicles were fitted with side airbags
- This would mean between 69,136 and 76,405 automatic triggers in GB (Please note: uninjured not included)

Automatic triggering conditions: Which accidents?

- Based on UK data:
  - If airbag deployment is used as trigger condition, more automatic emergency calls will be made for all accident types – and all injury severities.
  - If the trigger condition is only based on impacts similar to full-scale crash tests, this will reduce the number of automatic calls for all injury severities.
- Conclusions:
  - There is a lack of in-depth data across Europe and the world to base these estimates on, but airbag deployment will always initiate more calls and therefore be more effective for the most seriously injured casualties!
  - However, it will very likely also lead to a greater number of emergency calls that are not needed (uninjured occupants). Sound estimates of extent are not possible due to a lack of data.
- Recommended type approval requirement (Please note: airbag fitment not mandatory for any vehicles!):
  - Mandatory triggering at and above severity of full-scale crash tests
  - If vehicle is fitted with airbag(s): Automatic emergency call must at least be triggered with airbag deployment

Testing automatic triggering

Testing automatic triggering

- For type approval legislation a procedure must be defined for testing against the requirement to trigger (upper boundary of corridor) and to remain operable in an accident.
- Not realistic to require additional full-scale crash tests only for AECS. Limited selection of compulsory full-scale crash tests: UN R94, (future UN R13x), UN R12 and UN R95
  - These are of low severity in terms of risk of life threatening injuries in modern vehicles
  - But under real-world conditions (e.g. out of position, vulnerable people, unbelted occupants) they do involve risk of severe injury

Testing automatic triggering (continued)

- UN R94, (future UN R13x), UN R12 and UN R95 are an appropriate practical compromise to test automatic triggering threshold for most vehicles (airbags, if fitted, are always deployed)
- To consider:
  - Not all M1/N1 vehicles are tested in frontal *and* side impact
  - Larger vans and pickups don't have to be full-scale tested at all, but are still in scope if they are fitted with crash detection system/airbags (additional documentation might be requested from manufacturers to demonstrate that the triggering condition meet requirements)
  - Rollover and rear impact would not be tested

Testing operability after full-scale crash tests

- Inside crash test labs there is potentially no mobile network and GNSS coverage. Requiring to set up a dedicated network (e.g. using femtocells) is technically and legally complex across different countries.
- Exact practicalities of testing still need some consideration, but these general routes seem feasible:

A. If mobile network is present at test location:

  - Check if a test call is successfully performed after the crash test: Demonstrate Automatic triggering, successful test call to simulated PSAP using test number, successful transmission of minimum set of data
  - Please note: As different world regions use different mobile network standards, the system under test must be of a type that supports the mobile network standards in the region of testing. Repeated full-scale crash testing should not be required for derived versions supporting network standards of a different market.

B. If mobile network is *not* present at test location:

  - Check if automatic triggering occurred during crash test (log files); and
  - Demonstrate successful test call to simulated PSAP after crash test by moving vehicle to an area with network coverage.

Testing of low severity accidents

- Defining a lower boundary of accident severity in type approval legislation appears sensible to reduce unnecessary automatic emergency calls.
- Testing of lower triggering boundary is, however, not feasible with current full-scale crash tests, because no mandatory low-severity crash tests are available:
  - UN R42 (bumper test): Not compulsory e.g. in EU; severity too low to provide sensible boundary (pendulum impact at 4 km/h)
  - Non-legislated crash tests might be more appropriate, e.g. RCAR Low-speed structural crash test at 15 km/h, 40% overlap, rigid barrier (repairability), usually no airbag deployment. These are not compulsory.
- A solution to reduce unnecessary emergency calls needs to be identified. If testing is not feasible, potentially in form of additional documentation from the manufacturer during type approval.

Testing resistance to mechanical impact during accident

Testing resistance to severe accidents

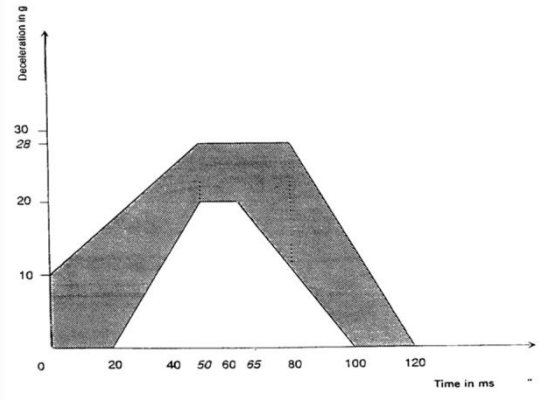
- Full-scale crash tests have been designed to pose a severe challenge to the crashworthiness of the vehicle's structure. However, under ideal conditions in modern vehicles these are not very severe, based on a risk of life-threatening injuries.
- In-vehicle system has to withstand much more severe accidents to realise the full benefit of automatic emergency call.
- Mechanical resistance to more severe impacts can be assessed in component tests (using a test sled or drop rig):
  - Simplified setup of components; operability check after exposition
  - Supplements full-scale crash testing with higher accelerations
  - Allows to simulate rear impacts and vertical loading
  - But not reliable for checking the full routing of cables, positioning of antennae, interactive audio systems, etc.

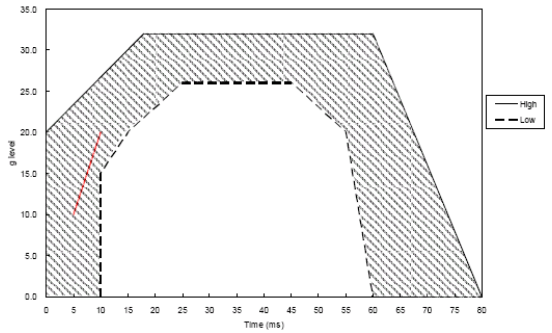
Severity of component tests

- Two test pulses representing frontal impacts are available in UN legislation and used for testing safety belt anchorages, seats, etc.:

  A. Max. acceleration: **20g**-28g
  Min. exceedance: 15 ms
  Used in UN R17, UN R44, UN R100, UN R129 and suggested in Draft AECS UN Regulation, Section 6.4 → Representative of 1970s/1980s crash tests; vehicle frontends stiffer nowadays; no added value over crash test!

  B. Max. acceleration: **26g**-32g
  Min. exceedance: 20 ms
  Used in UN R16 → Approximately representative of B-pillar acceleration in full-width crash test nowadays; no added value over crash test!





- Draft AECS UN Regulation, Annex 7 requires to withstand acceleration of **75g** for 1 to 5 ms → Level of acceleration is more representative of severe crash! Exceedance is very short (min. 1 ms); longer exceedance (e.g. 5 ms) would be more representative and still technically feasible.

Summary of TRL's recommendations

Recommendations

- Scope
  - Require AECS for M1/N1 vehicles fitted with crash detection sensor(s)
- Automatic triggering:
  - Requirements: Trigger at and above severity of full-scale crash tests. In addition, if vehicle is fitted with airbags: Trigger at least with airbag deployment.
  - Testing:
    - Demonstrate automatic triggering and successful test call during/after the applicable full-scale crash tests: UN R94, (future UN R13x), UN R12 and/or UN R95
    - For vehicles not undergoing mandatory full-scale testing: Additional documentation from manufacturer
    - Identify solution to prevent unnecessary low-severity emergency calls
- Resistance to mechanical impact during accidents:
  - Demonstrate operability after exposing core components of in-vehicle system to 75g for at least 5 ms

Thank you

Automatic triggering of emergency calls

AECS 4th meeting
28-30 April 2014

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