Transmitted by the Experts of OICA and CLEPA

Informal Document ACSF-06-18

6th ACSF meeting
Tokyo, 19-21 April 2016

Requirements for “Sensor view” & Environment monitoring

version 1.0

Detection means: Requirements for "Sensor view" & Environment monitoring

Current approach:

- Definition of sensor ranges for road environment monitoring
- Definition of tests to address main functionalities and critical scenarios

Aim:

- Avoidance / mitigation of collisions

Not clarified:

- What shall the defined "sensor range" and "monitoring" imply?
  - => detection within the defined ranges?
  - => recognition/classification within the ranges?
  - => initiation of countermeasures (transition demand issued, minimal risk manoeuvre initiated, …)?
- What needs to be detected?
  - => other road users? (normal driving conditions)
  - => obstacles? (emergency cases)

Prerequisite for respective tests:

- Pass/fail criteria for the tests has to be aligned with the defined requirements
- Tests need to be robust in view of reproducibility, repeatability, etc.

Detection means: Requirements for "Sensor view" & Environment monitoring

Alternative approach:

- General requirement for normal driving and emergency cases
  => ACSF has to deal with all normal driving scenarios and other road users
  => In emergency cases system has to react adequately
- Definition of tests to address main functionalities and critical scenarios

Aim:

- Ensure systems on the road, able to deal with all normal traffic situations and in emergency cases able to avoid or at least mitigate collisions

Prerequisite for respective tests:

- Pass/fail criteria for the tests has to be aligned with the defined requirements
- Tests need to be robust in view of reproducibility, repeatability, etc.

Detection means: Requirements for "Sensor view" & Environment monitoring

Proposed DRAFT wording:

5.6.1.1.8.	*The vehicle shall be equipped with means to monitor the driving environment, recognizing other road users and detecting obstacles in the path of driving.*
5.6.1.1.8.1.	*The system has to ensure, that under normal driving conditions neither the vehicle itself nor other road users will be negatively affected by the ACSF operation. In this regard, safety distances to other road users have to be respected. In case the system is not capable of recognizing other road users in the entire range of normal driving conditions, e.g. [in case of a lane change function] recognizing vehicles approaching with high differential speed on the adjacent lane or recognizing stopped vehicles at the rear end of a traffic jam ahead, the system shall ensure a safe operation of the ACSF by other means or manoeuvres or the respective function of the ACSF shall be deactivated.*
[5.6.1.1.8.2.	*In emergency cases, e.g. pedestrians stepping on the road, deer crossings or obstacles on the driving lane, the system shall be able to initiate adequate measures in order to avoid or mitigate collisions. Such measures [shall/may] consist of issuing a transition demand and/or the initiation of a minimal risk manoeuvre.]* ***Already addressed by 5.6.1.4.2.2., 5.6.1.2.5. and 5.6.1.6.1.2.? How to deal with cases without lead time?***
5.6.1.1.9	*The vehicle shall fulfill the tests for Category E as specified in Annex 7. In addition, in order to comply with 5.6.1.1.8.1. and 5.6.1.1.8.2., for the driving situations not covered by the tests of Annex 7, the safe operation of the ACSF shall be demonstrated by the vehicle manufacturer on the base of Annex 6.*

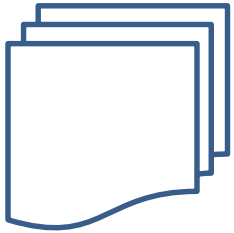
- No need to define ranges (ensure safety at any time)
- Check requirement by tests in Annex 7 and demonstrate overall system capabilities in Annex 6

Detection means: Requirements for "Sensor view" & Environment monitoring

How the new wording will work at type approval?

Assessment by the Tehnical Service during Type Approval

Annex 6

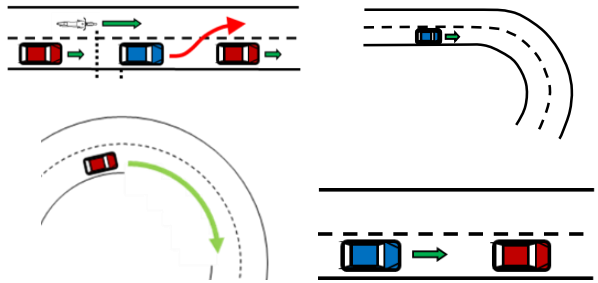


Scenario xxx: Vehicle with high differential speed approaching
System reaction: .....

Scenario yyy: Animal on highway
System reaction: .....

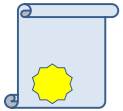
- Assessment of the safety concept: passed ☒ failed ☐
- Assessment during real road test drive: passed ☒ failed ☐

Annex 7



Test(s): passed ☒ failed ☐

Approval granted



Backup

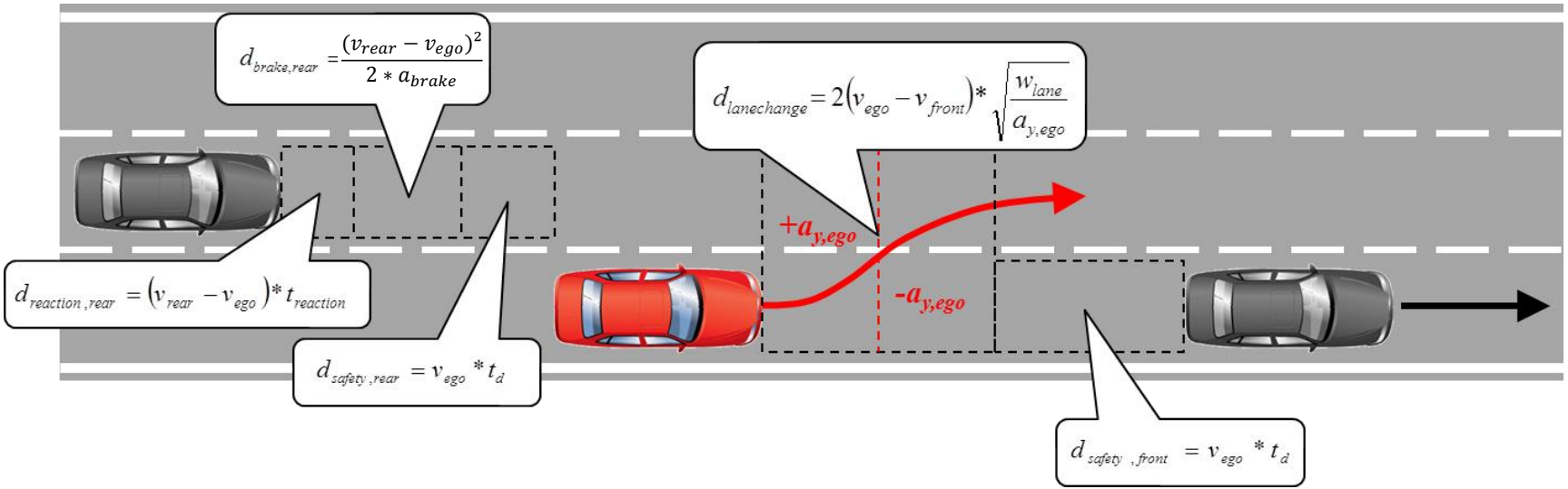
Detection means: Requirements for "Sensor view" & Environment monitoring

"Sensor view" requirements according to 5.6.1.1.8.

Former proposal → fixed values for front (176m), side (8m) and rear (113m)

Proposal ACSF-05-16 & ACSF-06-05 → equations (view depending on speed, deceleration, etc.)

"Safety distances" : no definitions/requirements



Detection means: Requirements for "Sensor view" & Environment monitoring

Clarification of current draft text:

5.6.1.1.8. The vehicle shall be equipped with means to monitor at any times when ACSF is active a minimum range to the front (s_{Front}), to the right (s_{side}), and to the left side (s_{side}) and behind (s_{Rear}) the vehicle with the purpose to avoid or to mitigate collisions.

Interpretation of "monitoring ranges"

The Vehicle shall
- recognize the environment incl. other road users, obstacles, etc. within the defined ranges *and*
- react on this environment in order to avoid or mitigate collisions.

What is the expectation of the group?

While other road users for the respective driving environment (e.g. "motorway" => motorbikes, cars, trucks and busses) could be recognized *(= detected and classified)* in the defined "monitoring ranges", pedestrians, animals or obstacles may not be recognized within the full ranges, but within reduced ranges.

Detection means: Requirements for "Sensor view" & Environment monitoring

Clarification of current draft text (continued):

5.6.1.1.8.1. The minimal range in front (s_{Front}) of the ACSF vehicle shall be calculated according to the following formula:

$$s_{front} = \frac{{v_{VUT}}^2}{2 * a_{VUT}}$$

German proposal ACSF-06-05: preplace v_{VUT} by v_{ACSF} and a_{VUT} by a_{ACSF}

where:

- s_{Front} = ***relative distance between the vehicle under test (VUT) equipped with ACSF and the vehicle driving in front, measured in meters from the front edge of the VUT to the rear end the vehicle driving in front.***
- v_{VUT} = ***speed of the vehicle under test measured in m/s***
- a_{VUT} = ***3.7 m/s² = feasible deceleration under wet conditions***

How to use the equations as a requirement?

v_{VUT} to be replaced by $v_{S,\ max}$

Detection means: Requirements for "Sensor view" & Environment monitoring

Clarification of current draft text (continued):

German proposal ACSF-06-05: preplace v_{VUT} by v_{ACSF}

5.6.1.1.8.2. The range to the rear (S_{Rear}) of the ACSF vehicle shall be calculated according to the following formula: $S_{Rear} = d_{reaction,\,rear} + d_{brake,rear} + d_{safety,rear}$

with: $d_{reaction,\,rear} = (v_{rear} - v_{VUT}) * t_{reaction}$ $\quad d_{brake,\,rear} = \frac{(v_{rear} - v_{VUT})^2}{2 * a_{brake}}$ $\quad d_{safety,\,rear} = v_{VUT} * t_d$

where:

- S_{Rear} = *relative distance between the vehicle under test (VUT) equipped with ACSF and the vehicle behind, measured in meters from the rear edge of the VUT to the front end of the vehicle behind.*
- $d_{reaction,\,rear}$ = *relative distance of the vehicle driving behind the VUT caused by the reaction of the driver to brake, measured in meters*
- $t_{reaction} = 1.2\ s$ = *reaction time of the driver driving the vehicle behind the VUT needed to execute the braking and to built up the full braking force, measured in seconds*
- $d_{brake,\,rear}$ = *braking distance of the vehicle driving behind the VUT ,measured in meters*
- $d_{safety,\,rear}$ = *safety distance between the vehicle under test (VUT) and the vehicle driving behind, measured in meters*
- $t_d = 1.0\ s$ = *safety time gap to VUT after braking, measured in seconds*
- v_{rear} = *[36.1 m/s] speed of the vehicle driving behind the vehicle under test (VUT) , measured in m/s.*
- v_{VUT} = *speed of the vehicle under test (VUT), measured in m/s.*
- $a_{brake} = 3\ m/s^2$ = *admissible deceleration of the vehicle driving behind the vehicle under test (VUT)*

How to use the equations as a requirement?

v_{VUT} to be replaced by $v_{ACSF,\,lane\ change,\,min}$

Definition for $v_{ACSF,\,lane\ change,\,min}$: „Specified minimum speed for lane change manoeuvres $v_{ACSF,\,lane\ change,\,min}$" means the minimum speed, below which the ACSF does not conduct any [automatic] lane change.

Detection means: Requirements for "Sensor view" & Environment monitoring

Clarification of current draft text (continued):

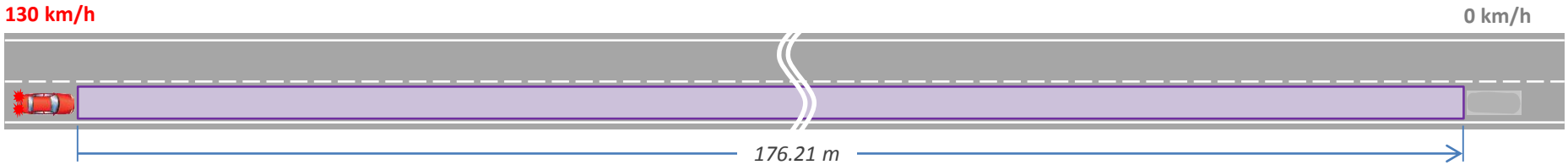
5.6.1.1.8.3. The range to the left and to the right (side) shall be at least 7m (measured from the medium longitudinal centerline of the vehicle)

5.6.1.1.9. The vehicle shall fulfil the tests for Category E as specified in Annex 7.

Detection means: Requirements for "Sensor view" & Environment monitoring

Example: ACSF is operable between 60 km/h and 130 km/h

Based on current draft requirements



$$s_{front} = \frac{(v_{S,max})^2}{2 * a_{VUT}}$$

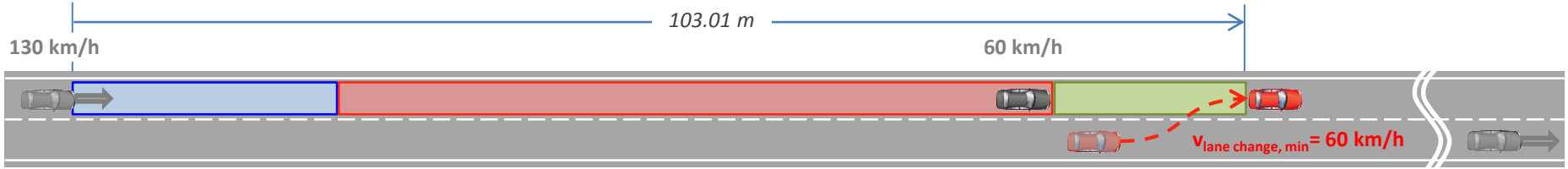
$$s_{front} = d_{brake,front} = \frac{(36.11\ m/s)^2}{2 * 3.7\ m/s^2} = \mathbf{176.21\ m}$$

$v_{ACSF,max}$	=	130.0 km/h
a_{VUT}	=	3.7 m/s²

Detection means: Requirements for "Sensor view" & Environment monitoring

Example: Lane change function of the ACSF is available between 60 km/h and 130 km/h

Based on current draft requirements



Safety distance (rear)

Reaction distance @ 130 km/h

$$d_{reaction,\,rear} = \left(v_{rear} - v_{ACSF,\,lane\ change,\,min}\right) * t_{reaction}$$

$$d_{reaction,\,rear} = 19.44\frac{m}{s} * 1.2s = 23.33m$$

Braking distance 130 → 60 km/h

$$d_{brake,\,rear} = \frac{\left(v_{rear} - v_{ACSF,\,lane\ change,min}\right)^2}{2 * a_{brake}}$$

$$d_{brake,\,rear} = \frac{(19.44m/s)^2}{2 * 3.0\ m/s^2} = 63.01m$$

Safety distance @ 60 km/h

$$d_{safety,\,rear} = v_{rear,post\ braking} * t_d = v_{ACSF,\,lane\ change,\,min} * t_d$$

$$d_{safety,\,rear} = 16.67\frac{m}{s} * 1.0s = 16.67m$$

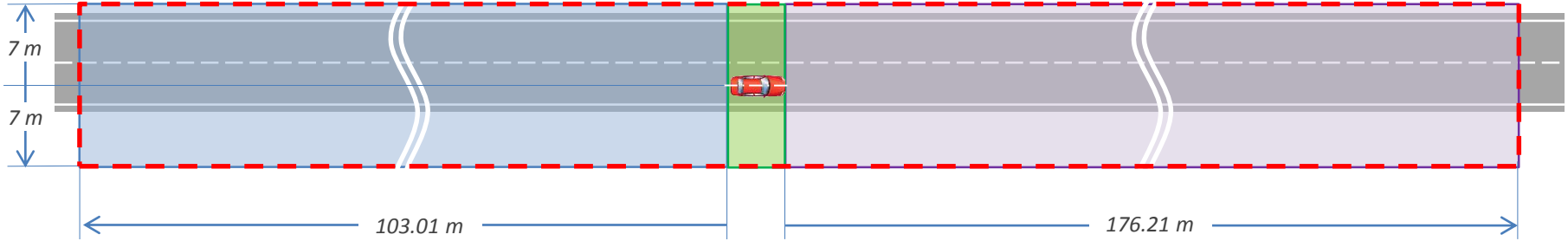
$$d_{sensor\ view,\,rear} = d_{reaction,\,rear} + d_{brake,\,rear} + d_{safety\ distance\ @\ 60\ km/h} = 103.01\ m$$

v_{rear}	=	130.0 km/h
$v_{ACSF,\,lane\ change,min} = v_{rear,post\ braking}$	=	60.0 km/h
$t_{reaction}$	=	1.2 s
$a_{brake,\,driver}$	=	3.0 m/s²
t_d	=	1.0 s

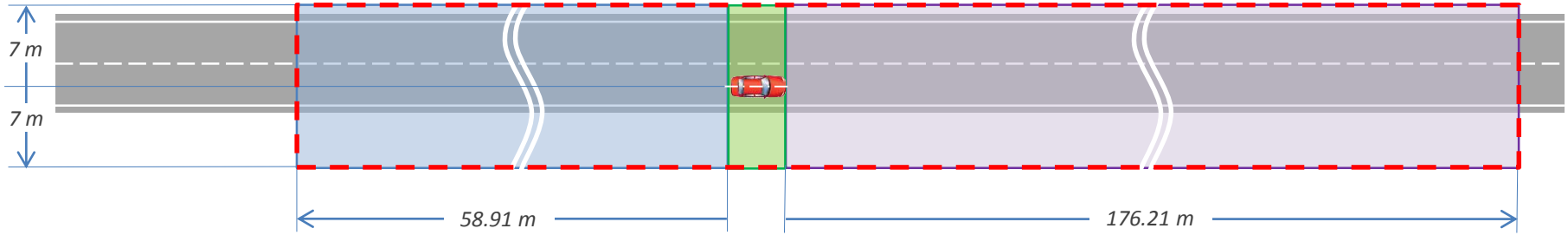
Detection means: Requirements for "Sensor view" & Environment monitoring

Based on current draft requirements

Example #1: ACSF (incl. lane change) is operable between 60 km/h and 130 km/h



Example #2: ACSF (incl. lane change) is operable between 90 km/h and 130 km/h



= Expected range to be monitored by the system for the given example (ACSF Category E)