Informal Document: **ACSF-04-05**

Federal Ministry
of Transport and
Digital Infrastructure

bast

Safety Distances and Object Classifications for ACSF

Federal Ministry
of Transport and
Digital Infrastructure

Safety Distances

Aim:
No collision with other road users, road furniture or other objects while using ACSF

Rationale:
- ACSF may encourage driver to carry out secondary tasks so that he is distracted or looses situation awareness
- ACSF actions may affect other road users (e.g. during a lane change)

Solution:
Requirements for safe distances (without endangering other traffic) at which speed and position of other objects should be classified

Federal Ministry
of Transport and
Digital Infrastructure

Safety Distances (Front)

Safe distances (without endangering other traffic) at which speed and position of other objects should be classified:

x: relative Distance m
v: Speed km/h
a: Deceleration m/s^2
FOC: Front Object Classified
BD: Brake Distance m
FO: Front Object
VUT: ACSF Car (Vehicle Under Test)

a_{VUT} includes the deceleration built up phase

Front:

$$x_{FOC} = x_{BD} = v_{VUT}^2 / (2 \cdot a_{VUT})$$

- Reference is the vehicle front end
- Reaction time is not needed because of the automatic protective brake

Example to ‚Collision Avoidance with Stationary Target Test‘:
v_{VUT} = 120 km/h,
BD with mean deceleration of a $_{VUT}$ = 3.7 m/s^2 (min. value for wet roads in German directive for road construction)
V_{FO} = 0 km/h

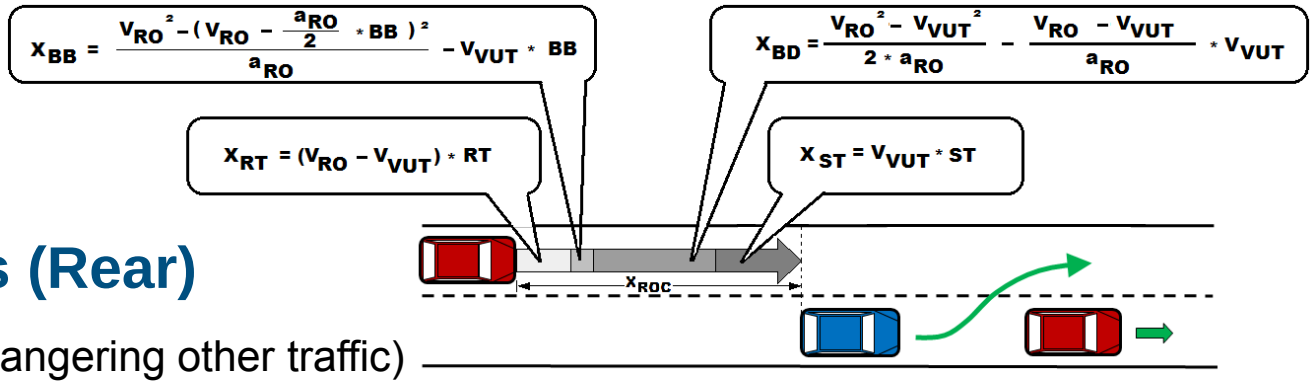
$$\Rightarrow x_{FOC} = \underline{150.1\ m}$$

Worst Case*:
v_{VUT} = 130 km/h,
BD with mean deceleration of a $_{VUT}$ = 3.7 m/s^2
V_{FO} = 0 km/h

$$\Rightarrow x_{FOC} = \underline{\mathbf{176.2\ m}}$$

*Driving with max. system speed of 130 km/h

Federal Ministry
of Transport and
Digital Infrastructure



Safety Distances (Rear)

Safe distances (without endangering other traffic) at which speed and position of other objects should be classified:

Rear: $x_{ROC} = x_{RT} + x_{BB} + x_{BD} + x_{ST}$

(Reference is the vehicle rear end)

Example to Lane Change Test‘:
v_{VUT} = 22,2 m/s (80 km/h),
v_{RO} = 36,1 m/s (130 km/h), RT = 1.2 s,
BB = 0.5 s (to a_{RO} = 3 m/s² with 6 m/s³),
BD with max. reasonable deceleration of a_{RO} = 3 m/s²,
ST 1 s
=> x_{ROC} = 16.7 m + 6.8 m + 32.2 m + 22.2 m = 77.9 m

Worst Case*:
v_{VUT} = 16,6 m/s (60 km/h),
v_{RO} = 36,1 m/s (130 km/h), RT = 1.2 s,
BB = 0.5 s (to a_{RO} = 3 m/s² with 6 m/s³),
BD with max. reasonable deceleration of a_{RO} = 3 m/s²,
ST 1 s
=> x_{ROC} = 23.3 m + 9.5 m + 63.0 m + 16.7 m = **112.5 m**

x: relative Distance m
v: Speed km/h
a: Deceleration m/s²
ROC: Rear Object Classified
RT: Reaction Time s*
BB: Brake Built up time s*
BD: Brake Distance m*
ST: Safety Time gap to VUT after braking s*
RO: Rear Object
VUT: ACSF Car (Vehicle Under Test)

*for Rear Object driver

x_{BB} is calculated with a mean deceleration $a_{RO}/2$ = 1.5 m/s²

*German Autobahn: Normal driving without traffic jam for full speed range system (up to max. 130 km/h)

Federal Ministry
of Transport and
Digital Infrastructure

Safety Distances (Sides)

Safe distances (without endangering other traffic) at which speed and position of other objects should be classified:

Sides:

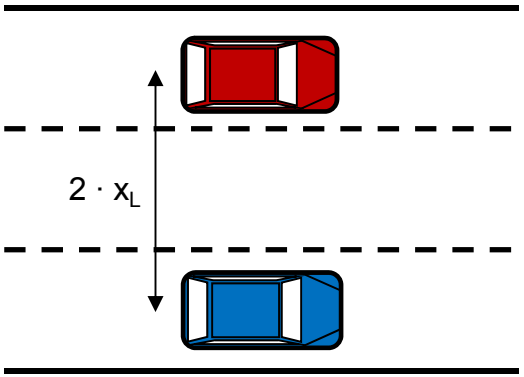
$$x_{SOLC} = x_{SORC} = 2 \cdot x_L$$

•Reference is the vehicle longitudinal axis because this is independent from the vehicle width and the lane width is defined
•Reaction time is not needed because lateral velocities are low and automatic steering is active

Assumed case*:
x_L = 4 m (lane width),
VUT must be abel to check two lanes for objects to the desired side for a lane change

$$\Rightarrow x_{SOLC} = x_{SORC} = \underline{\mathbf{8\ m}}$$

(to each side of the vehicle longitudinal axis)



x: Distance m
SOLC: Side Object Left Classified
SORC: Side Object Right Classified
L: Lane
VUT: ACSF Car (Vehicle Under Test)

*German Autobahn: Normal driving on a 3-lane Autobahn

Federal Ministry
of Transport and
Digital Infrastructure

360° Surround View on Safe Distances