Investigation of another vehicle performance by creeping procedure

National Traffic Safety and Environment Laboratory

Purpose of this report

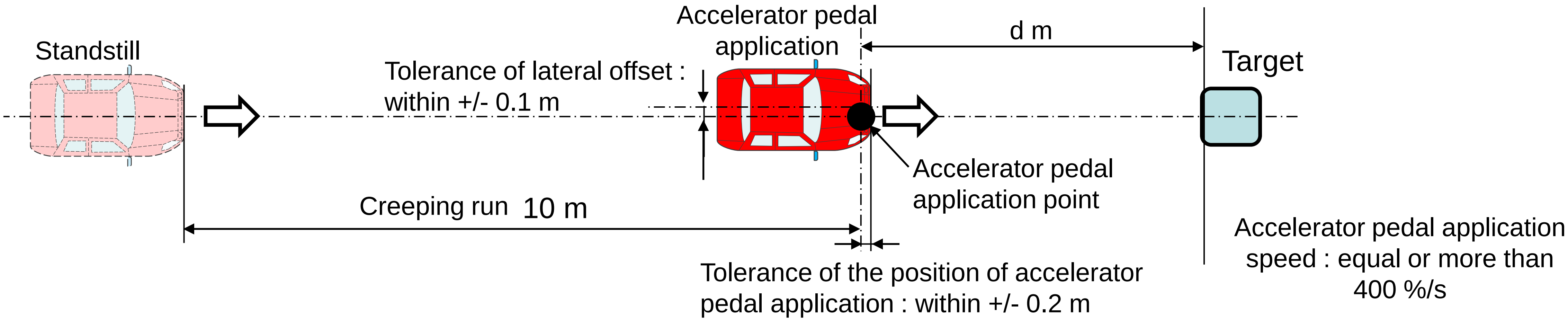
- The purpose of this report is to share another vehicle (Vehicle B) data tested by creeping procedure.

  (Data of vehicle A has been reported in ACPE-06-04.)
- To discuss appropriate distance to the target in the creeping test procedure.
- This report doesn't intend to propose the performance requirement in the creeping test procedure.

Abstract of the experimental procedure

Republish (ACPE-06-04)

- The driver released brake pedal. And the vehicle runs 10 m with creeping speed.
- The driver applies accelerator pedal at the accelerator pedal application point which is fixed. The reason why the distance of creeping run and the position of accelerator pedal application are fixed is in order to minimize the deviation of the distance as much as possible between the position of accelerator pedal application and the target.
- Both the steering control and accelerator pedal were operated within the tolerances by a professional driver.



Experimental conditions and parameters

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(ACPE-06-04)

<Targets>

- 3D type vehicle target (in accordance with ISO 19206-3:2018)
- Adult pedestrian target (in accordance with ISO 19206-2:2018)
- Child pedestrian target (in accordance with ISO 19206-2:2018)
- No target

<Vehicle speed>

Creeping (Air conditioner of the vehicle was activated)

<Accelerator pedal application speed>

Equal or more than 400 %/s (It was applied so as to reach 100 % within 0.25 s).

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Experimental conditions and parameters

<Distance from the accelerator pedal application point to the target>

•1 m

•1.5 m

•2 m

•3 m

<Running direction of the vehicle>

•Forward direction

•Backward direction

<The number of trials>

In principle, 3 trials were conducted in each experimental condition.

Measurement of data

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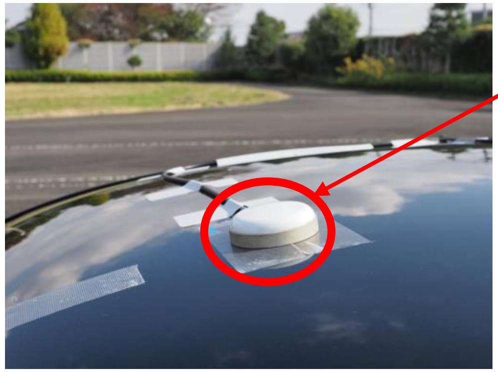
(ACPE-06-04)

- Longitudinal and lateral position of the vehicle and velocity of the vehicle were measured accurately by RTK GPS (OxTS RT-range).
- Accelerator pedal position was measured by recording the change of voltage.

GPS Antennas



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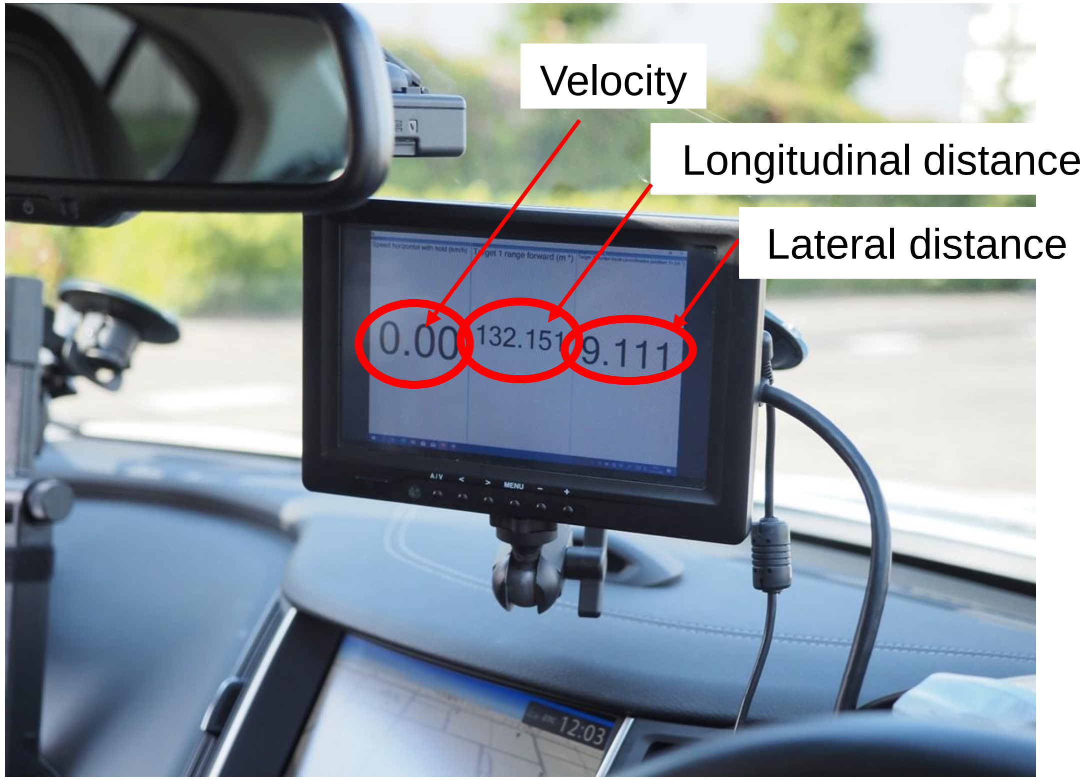
- Through the monitor on the dashboard, velocity, longitudinal distance and lateral distance of the vehicle were provided to the driver in real time as the guidance in order to drive within the tolerances.



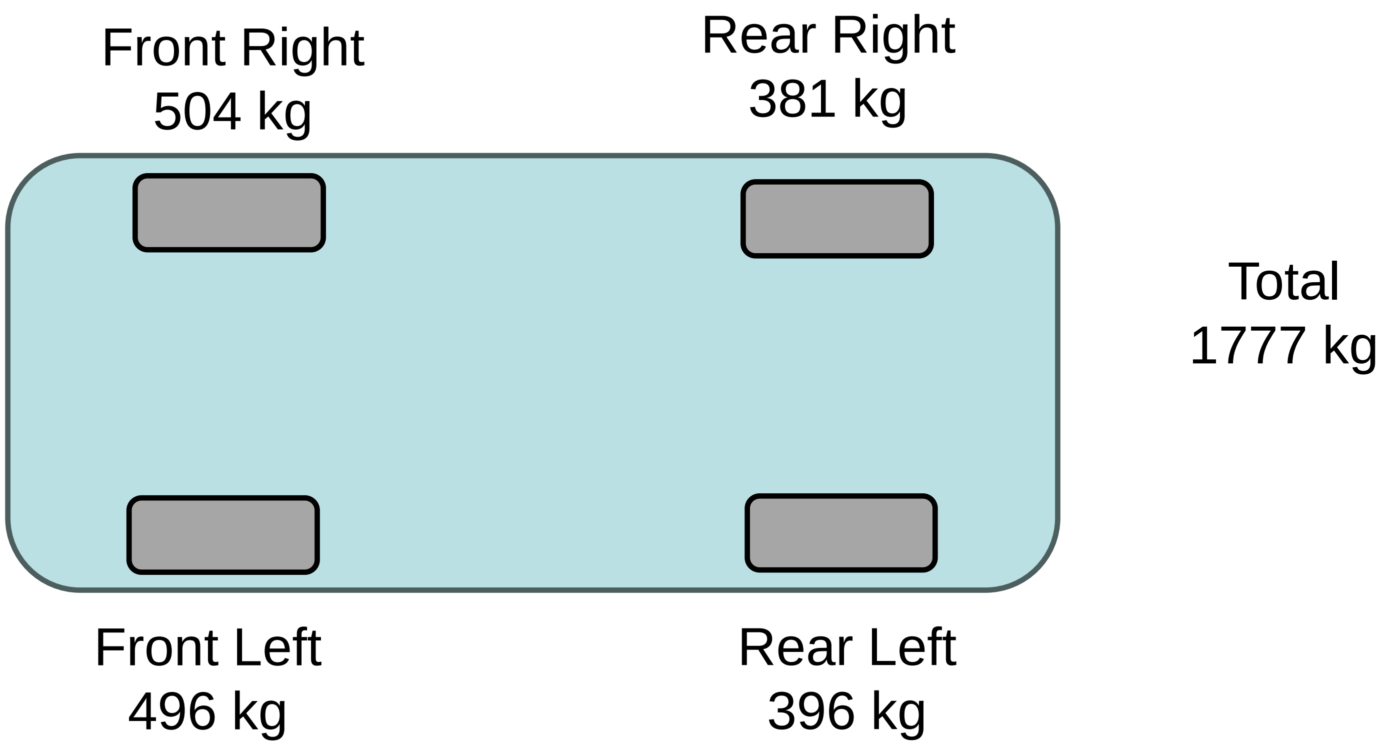
Profile of the experiment vehicle (Vehicle B)

Registration	Nov. in 2021	
Powertrain	1.8 litre turbo charged petrol engine CVT transmission	
Driven wheels	Front and Rear (AWD)	
Sensing system	Front	Camera (Stereo type)
	Rear	Sonars[*1]
ADAS functions	ACC, LKAS, AEBS, ACPE etc.	
Deactivation of ACPE	Both AEBS and ACPE can be manually deactivated simultaneously (It is impossible to be deactivated individually)	

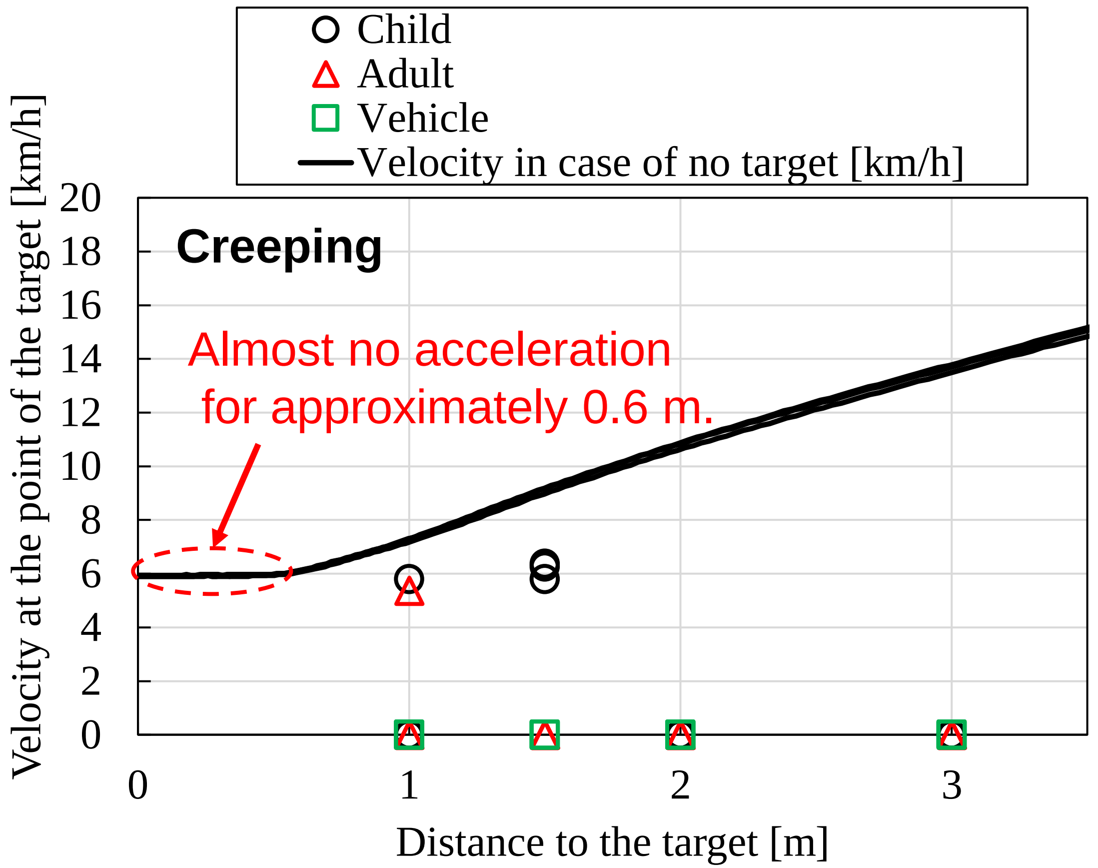
[*1]Regarding backward direction, acceleration control (not including braking control) is activated for a few seconds by sudden accelerator pedal application even if there is no obstacle.

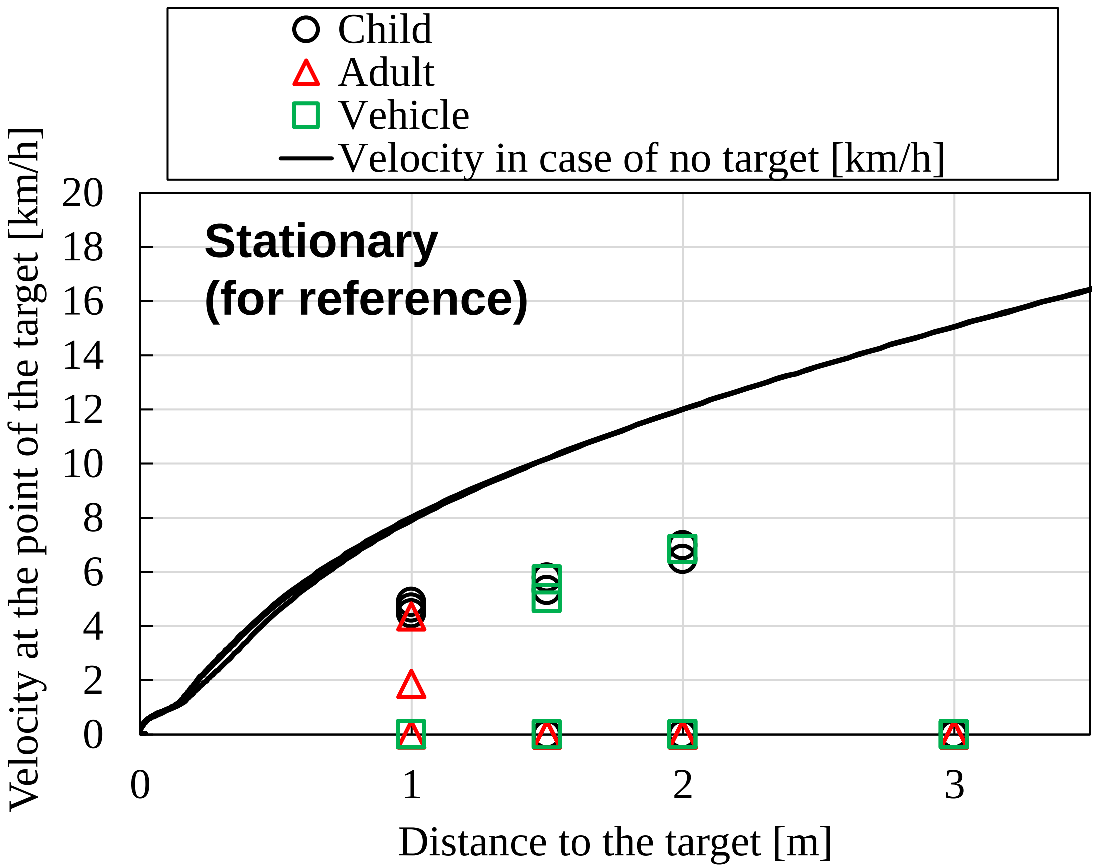
Profile of the experiment vehicle (Vehicle B)

Vehicle mass during the experiment
(including the measurement devices, the driver, and second person who is responsible for measurement of data)



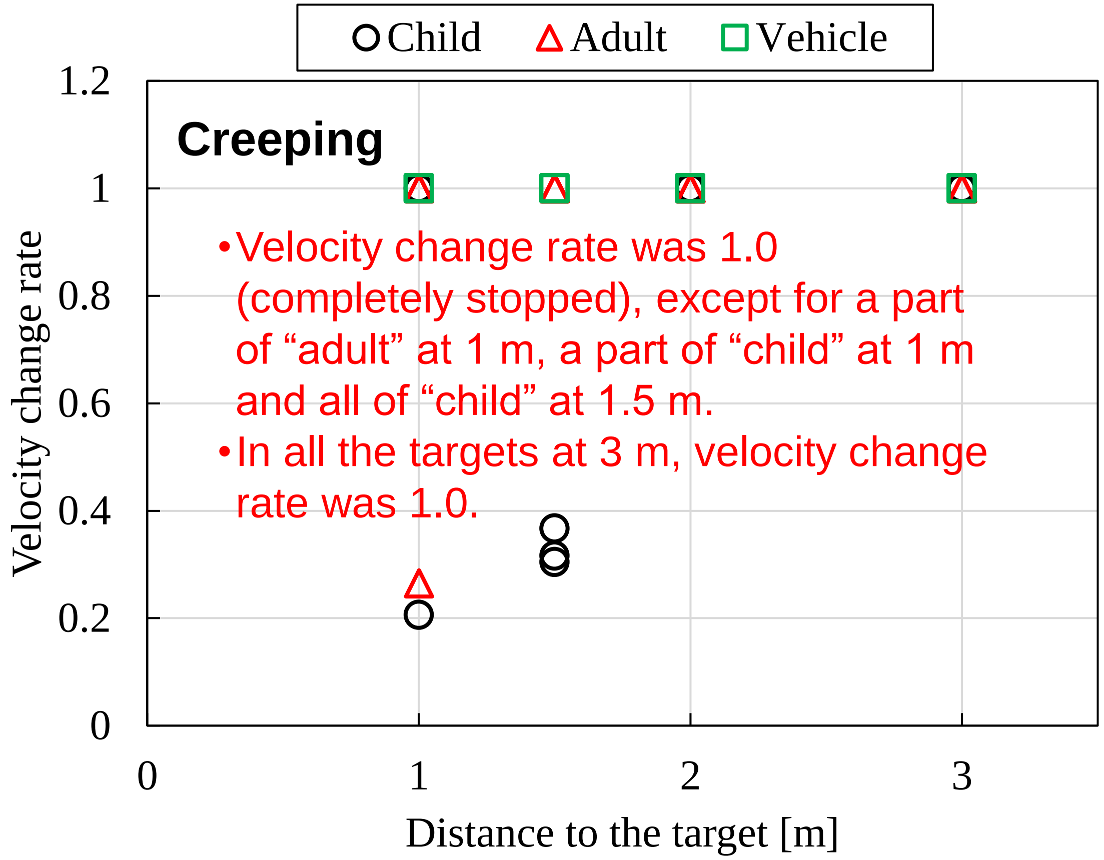
Experimental result (Forward direction, Velocity)

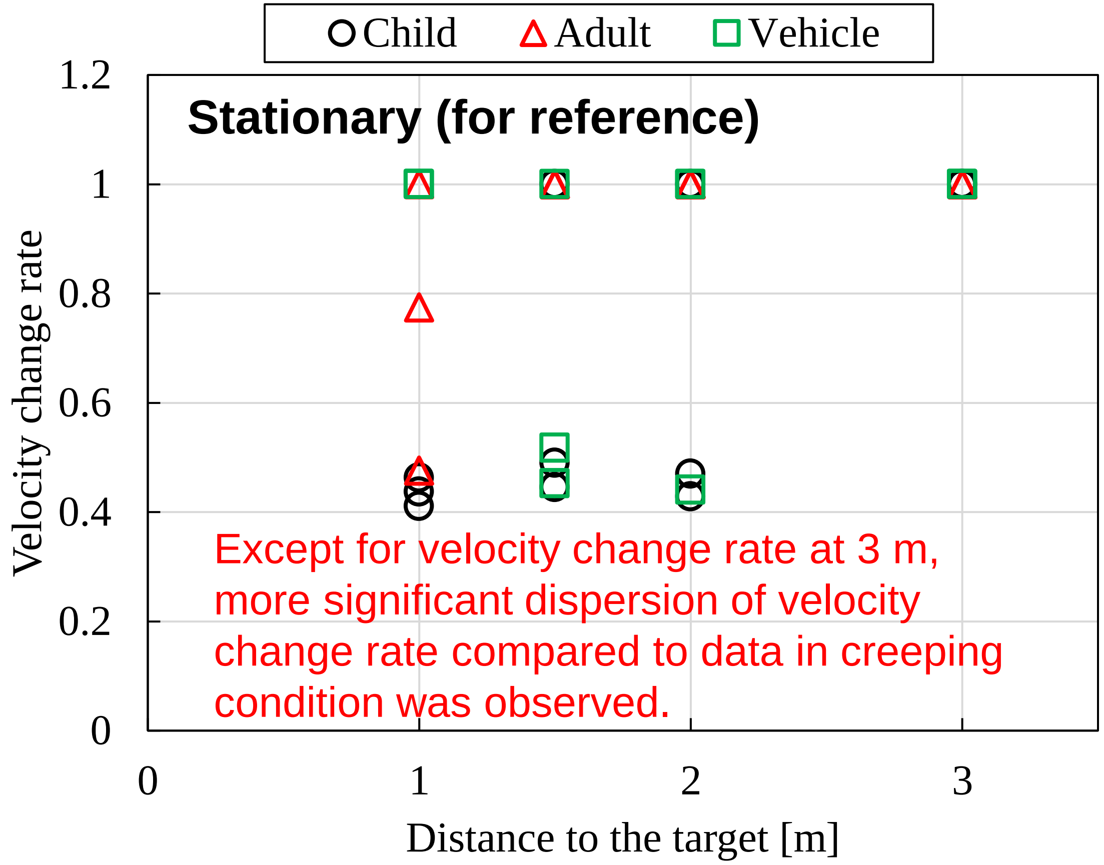




- In case of creeping condition, the vehicle didn't accelerate for approximately 0.6 m.
- Speed increase was approximately 1.2 km/h at 1 m (big difference compared to stationary condition).

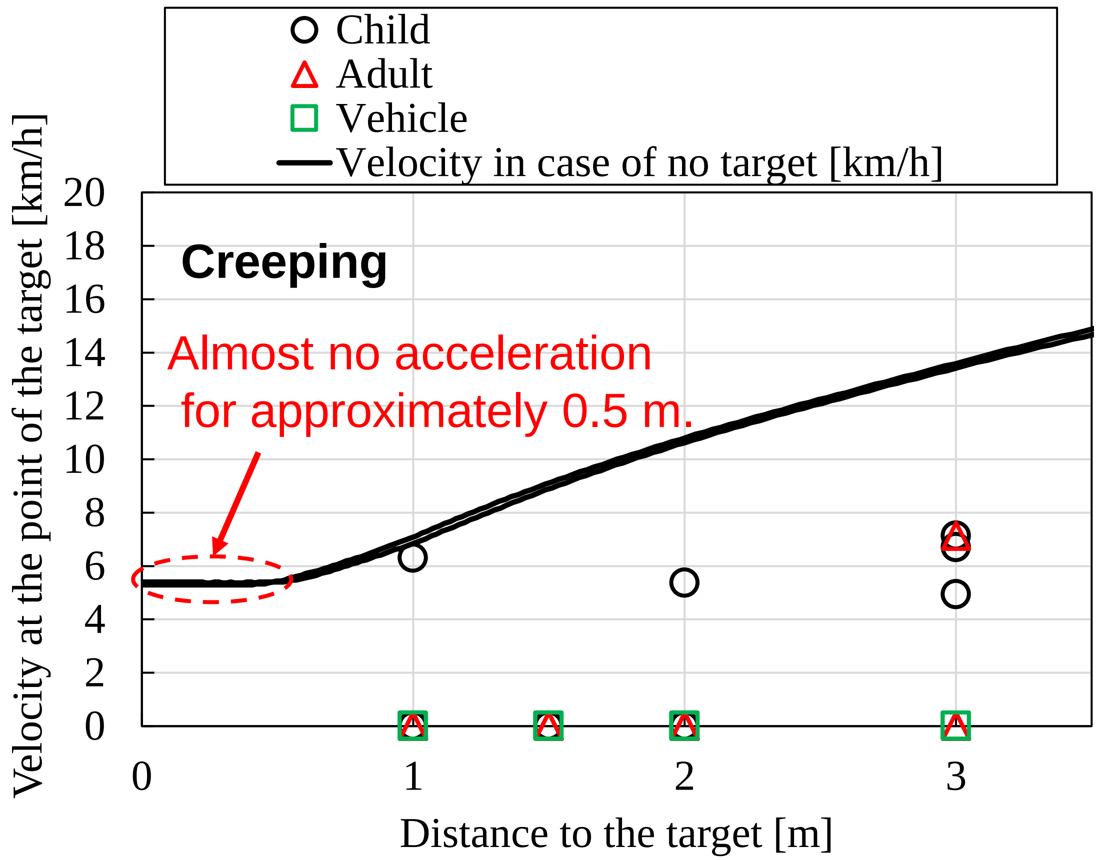
Experimental result (Forward direction Velocity change rate*)

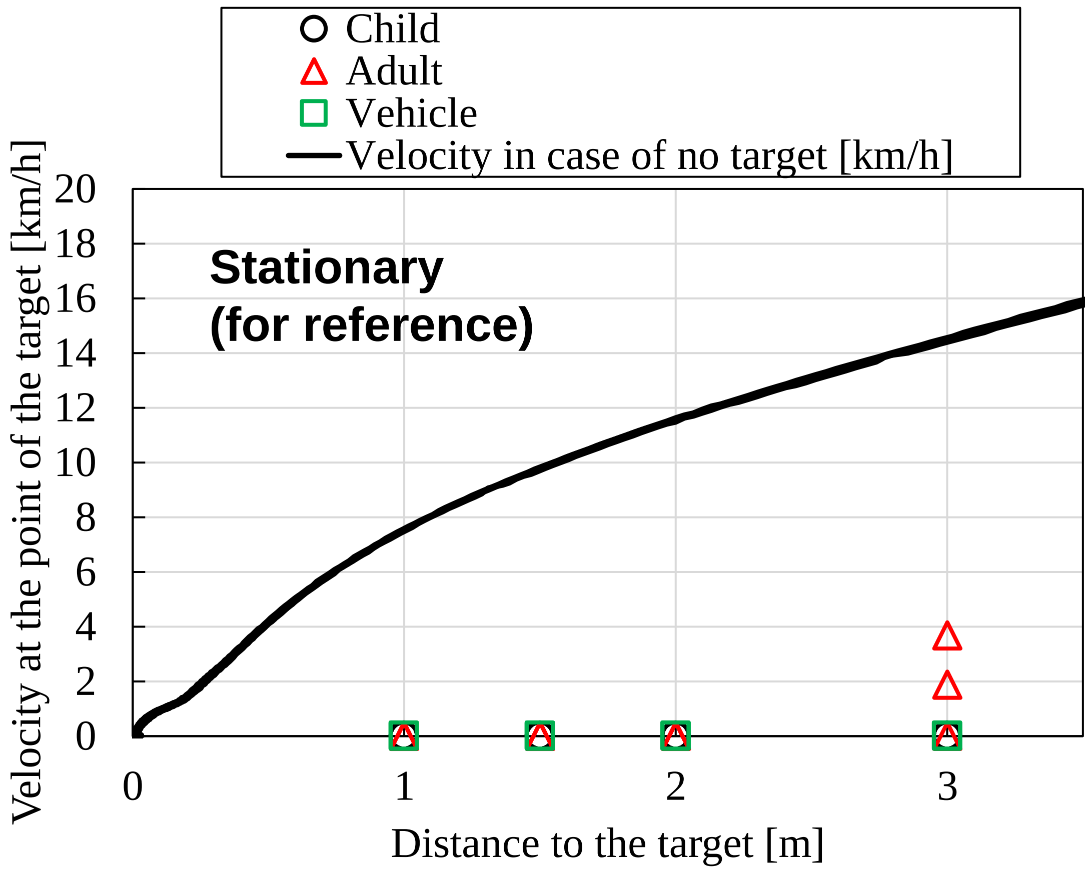




$$^{*}\text{Velocity change rate} = \frac{\text{(velocity at the point of target with “no target”)} - \text{(velocity at the target point with a target)}}{\text{(velocity at the point of target with “no target”)}}$$

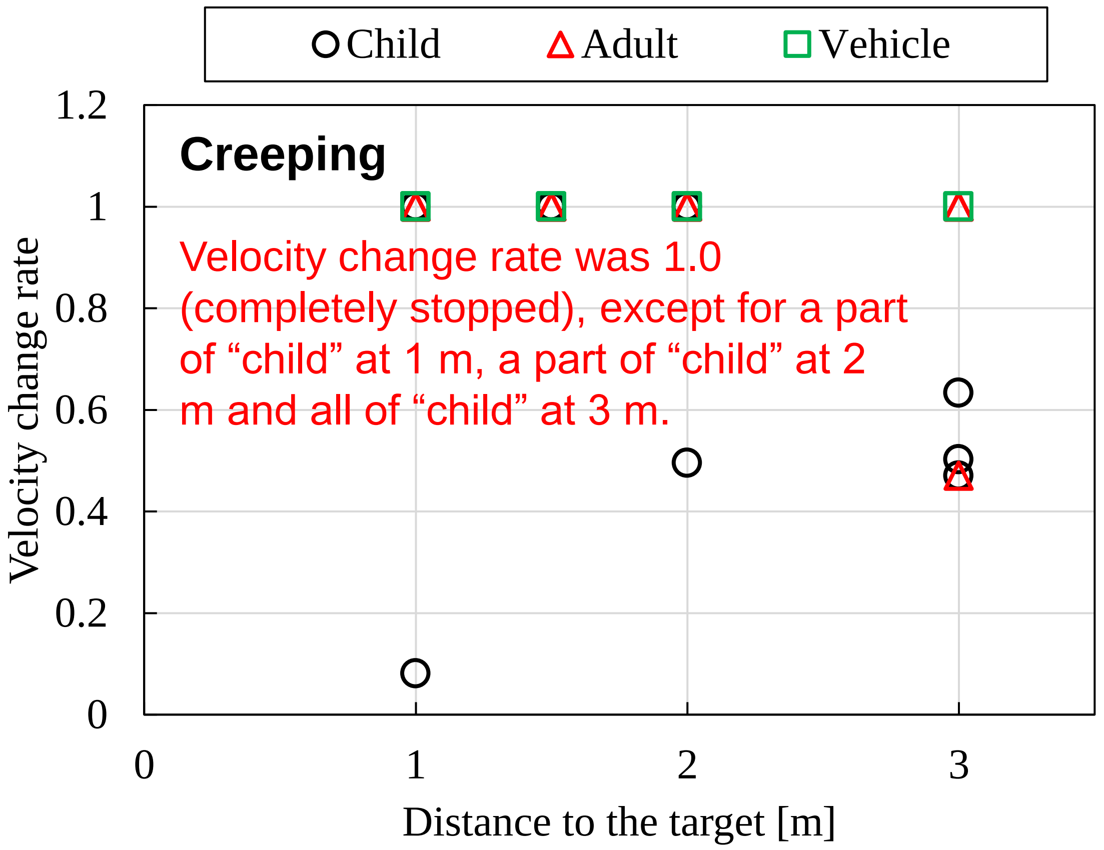
Experimental result (Backward direction, Velocity)

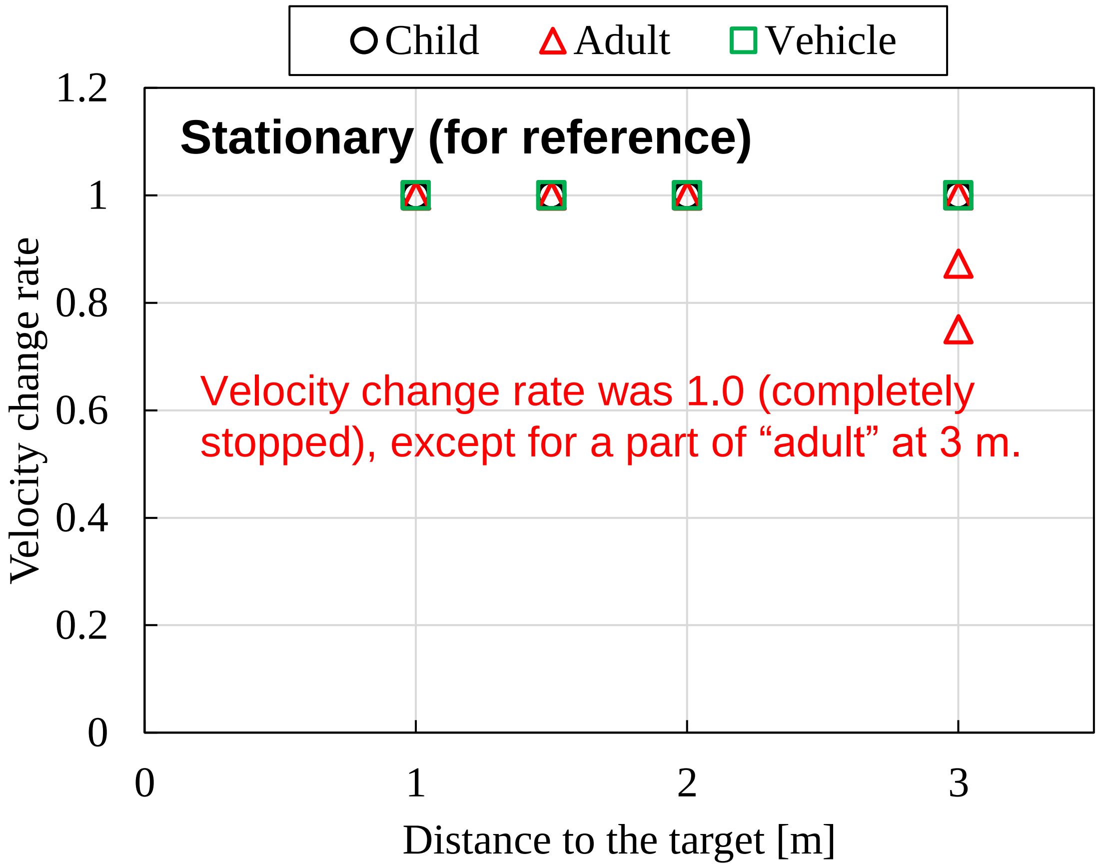




- In case of creeping condition, the vehicle didn't accelerate for approximately 0.5 m.
- Speed increase was approximately 1.7 km/h at 1 m (big difference compared to stationary condition).

Experimental result (Backward, Velocity change rate*)



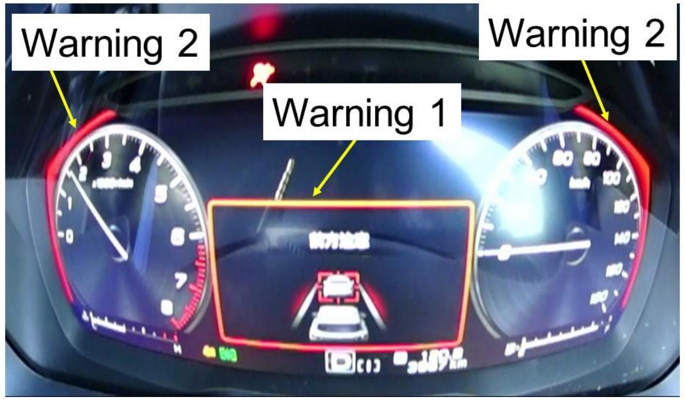


$$^{*}\text{Velocity change rate} = \frac{(\text{velocity at the point of target with “no target”}) - (\text{velocity at the target point with a target})}{(\text{velocity at the point of target with “no target”})}$$

Experimental result (Examples of detail data)

The following slides shows the examples of detail data.

Definition of the words in the figures



Warning 1 : The warning starts to display when the system determines high possibility of a collision. The primary braking control and reducing engine torque are carried out.
When the system determines much higher possibility of a collision, the secondary braking control (higher deceleration) is carried out. It is continued to display until the secondary braking control is finished. This warning is **not** specified for ACPE.

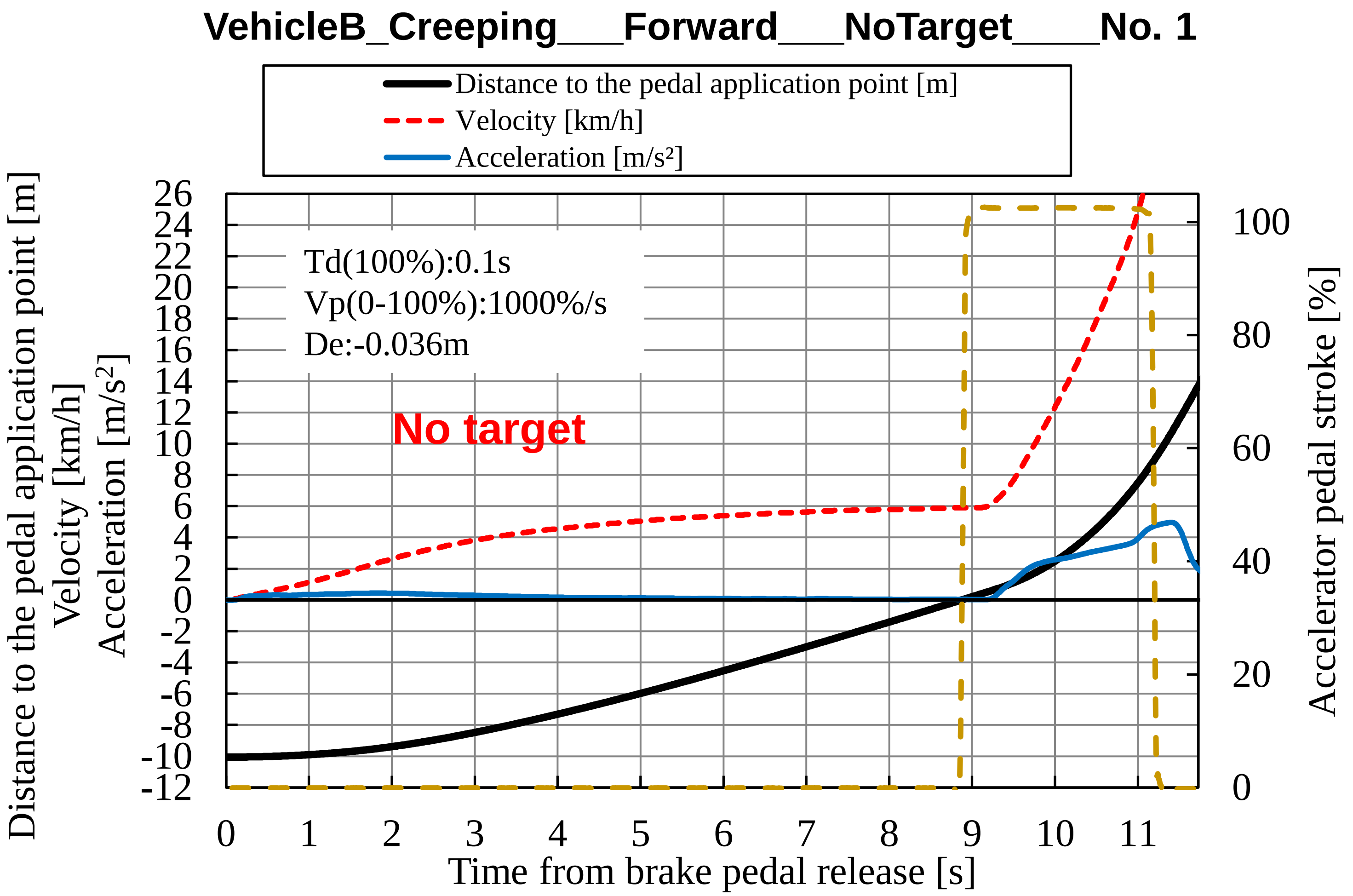
Warning 2 : The warning starts to display when the secondary braking control is started. This warning is **not** specified for ACPE.

Td(100%) : The time of accelerator pedal application from 0% to reaching 100% [s]

Vp(0-100%) : Accelerator pedal application speed [%/s]

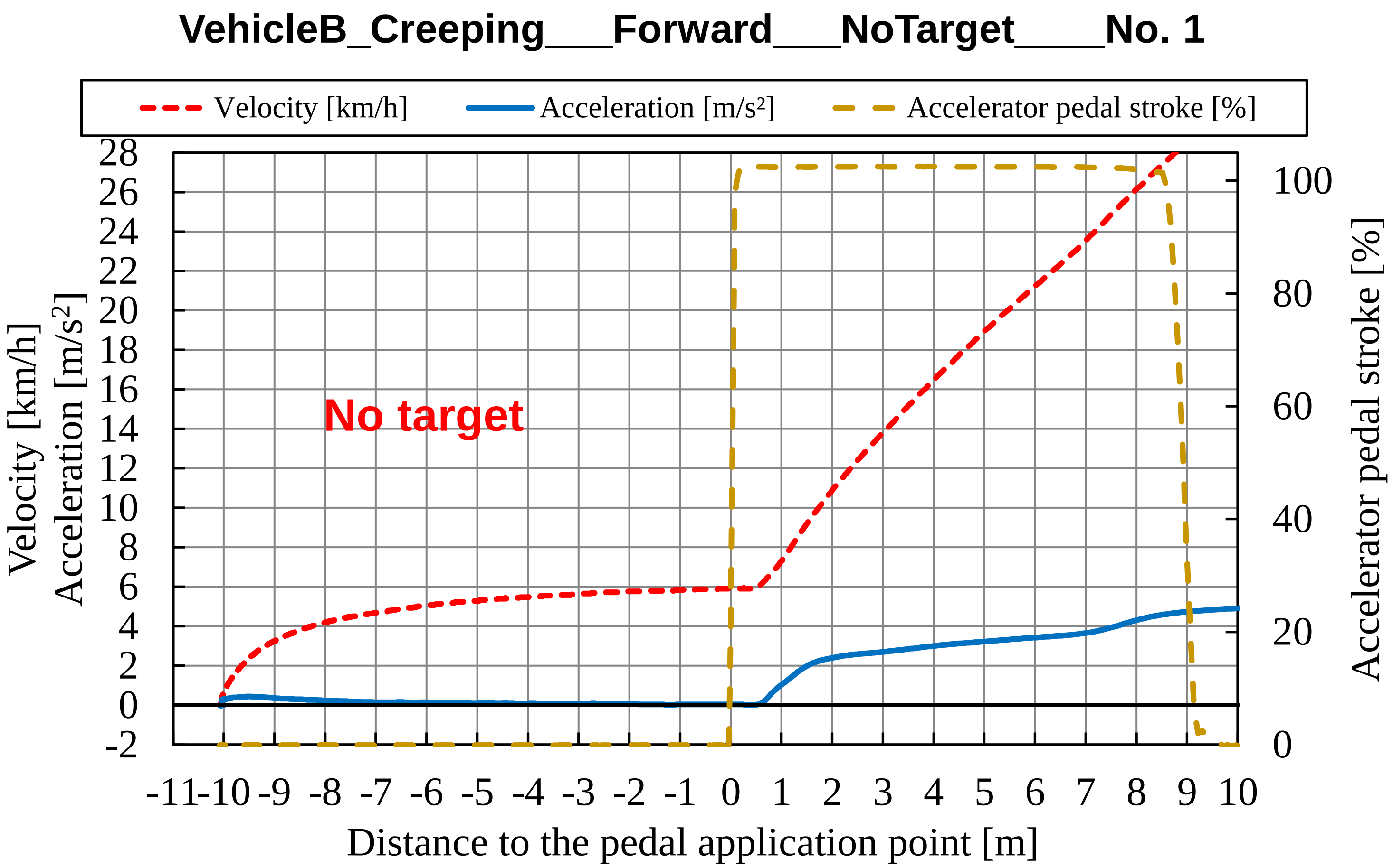
De : Error of distance at the point of accelerator pedal application [m]

Experimental result (Examples of detail data, Forward direction)



- Maximum acceleration of the vehicle (just before accelerator pedal was off) was approximately 4.5 m/s^2 in the condition of "no target".

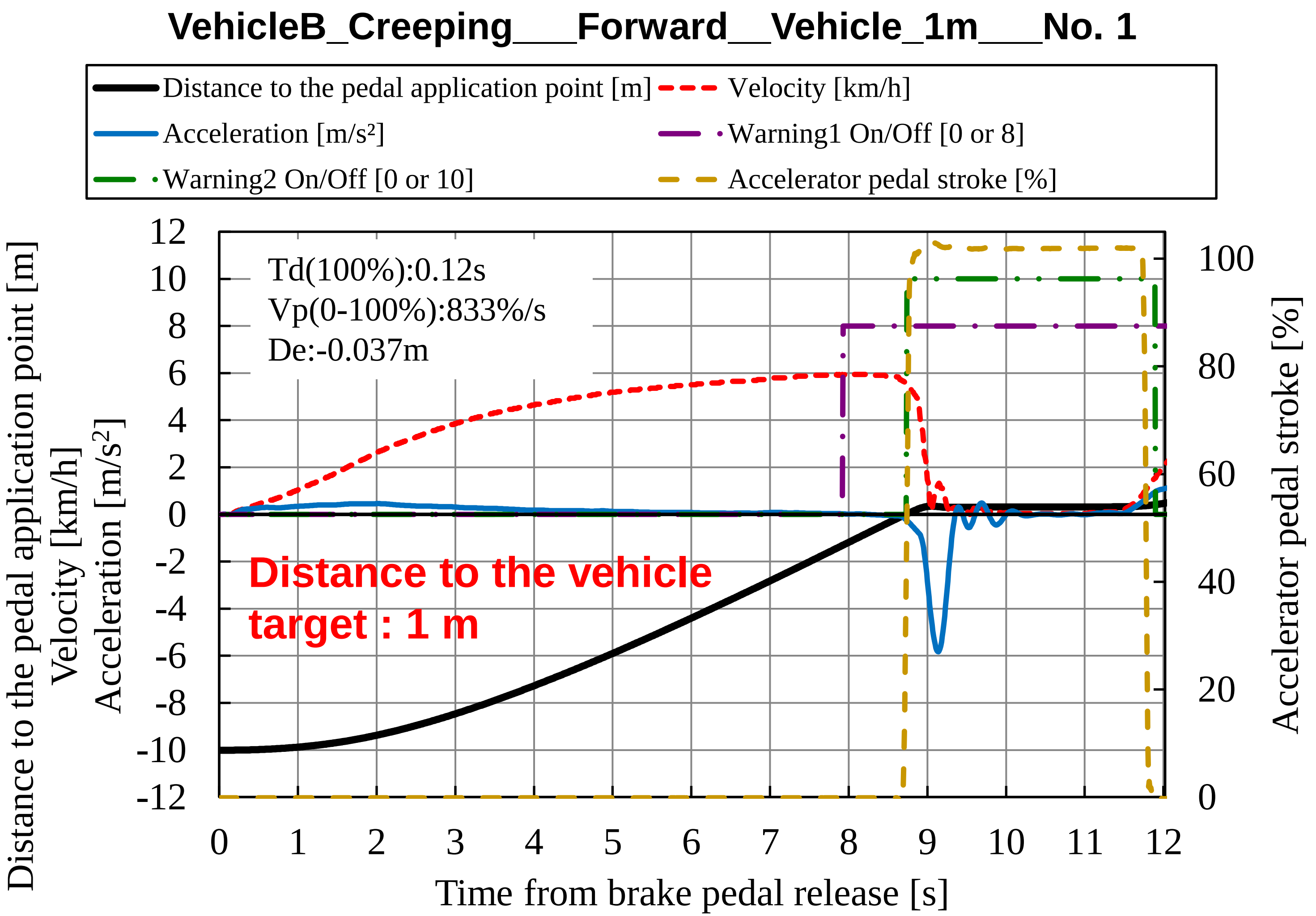
Experimental result (Examples of detail data, Forward direction)



- Creeping speed was approximately 6 km/h, just when accelerator pedal was applied. And then, velocity reached almost steady value.
- The vehicle didn't accelerate almost for approximately 0.6 m just after the accelerator pedal was applied.

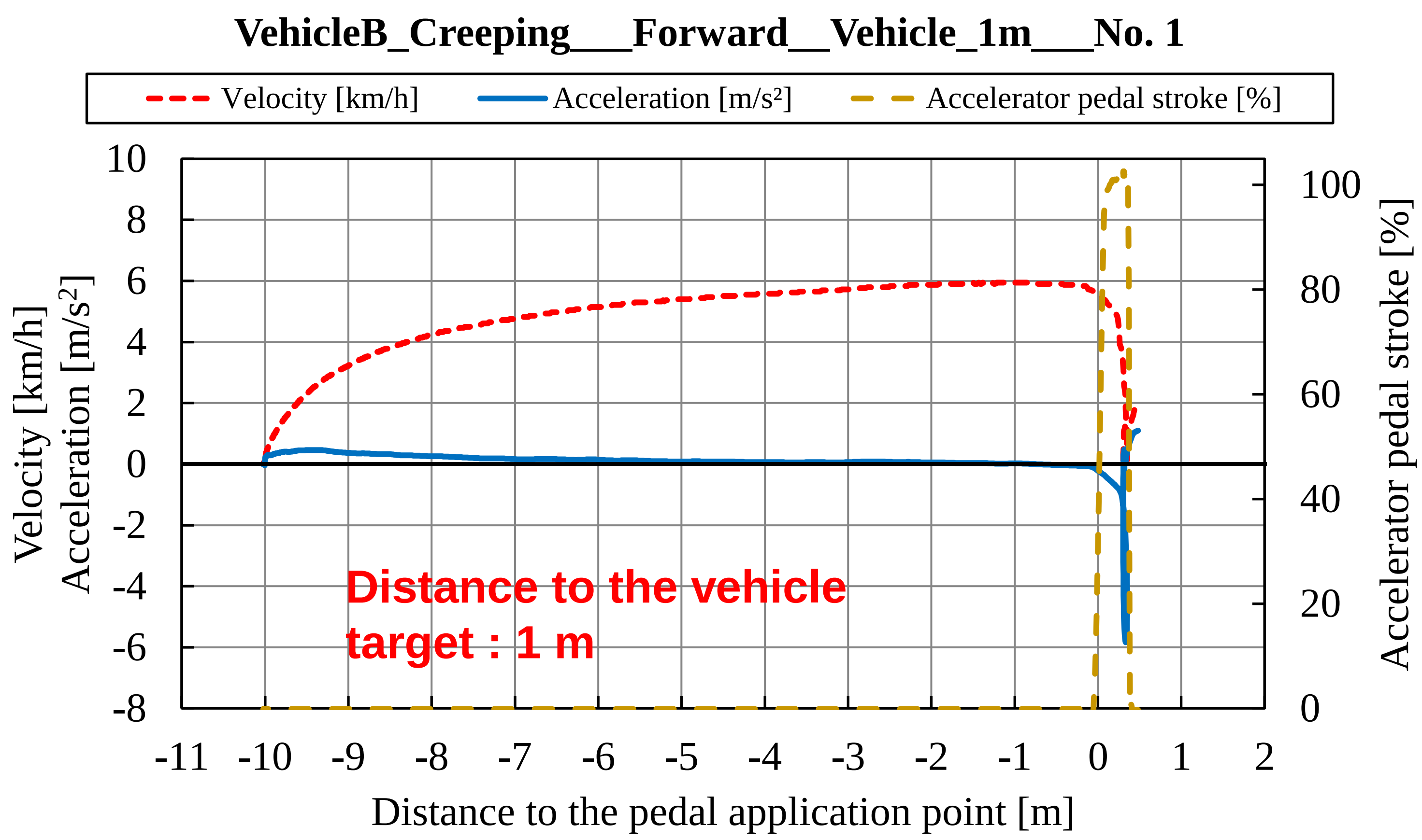
⇒Distance from accelerator pedal application point to the target should be considered carefully.

Experimental result (Examples of detail data, Forward direction)



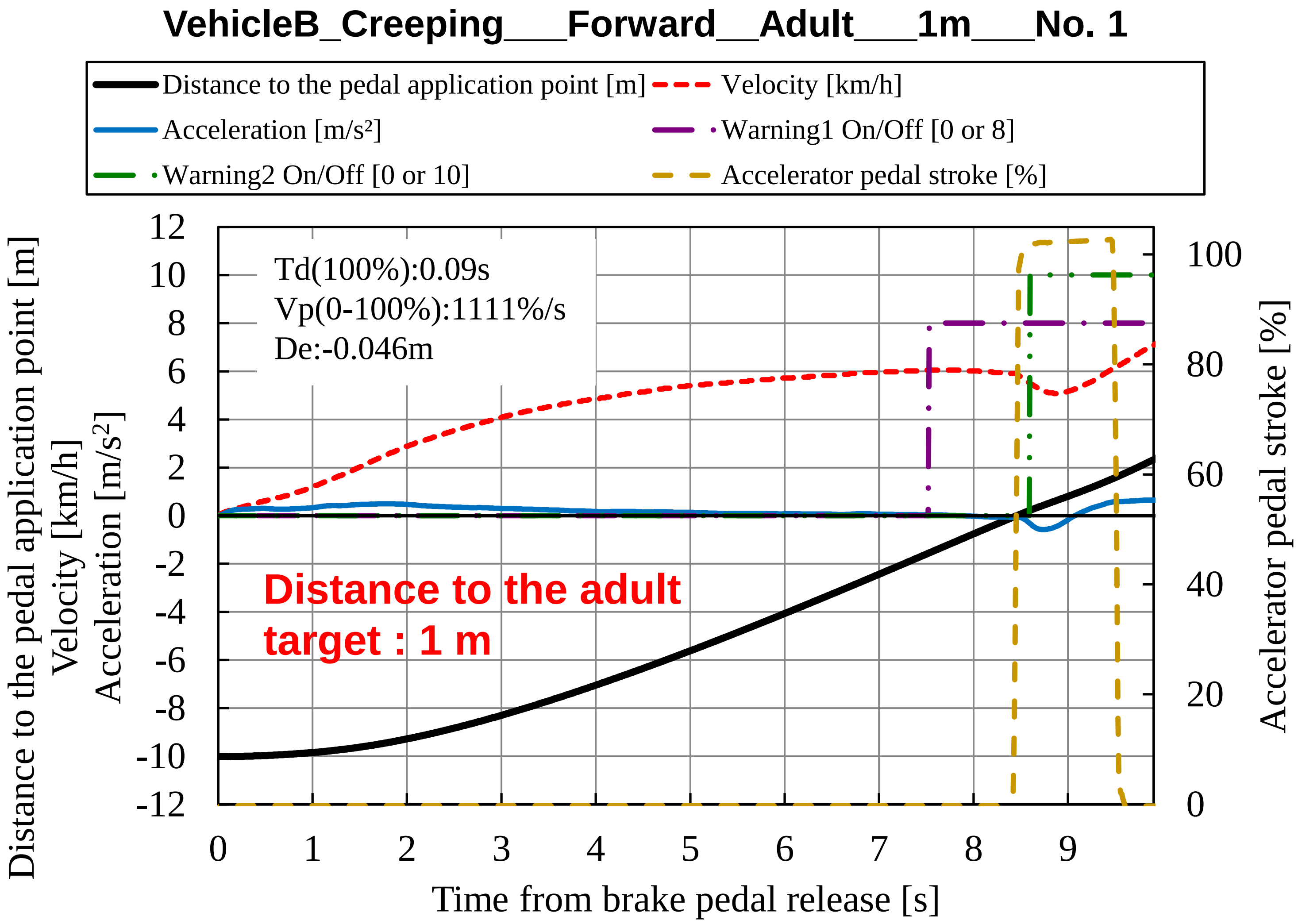
- Acceleration control was continued for more than 2 sec..
- The vehicle was decelerated and completely stopped.
- It is difficult to distinguish whether braking control was carried out by AEBS or ACPE, because the warning 1 was begun approximately 0.8 sec. before the start of accelerator pedal application, and also the warning 2 was begun at almost the same time as the start of accelerator pedal application.

Experimental result (Examples of detail data, Forward direction)



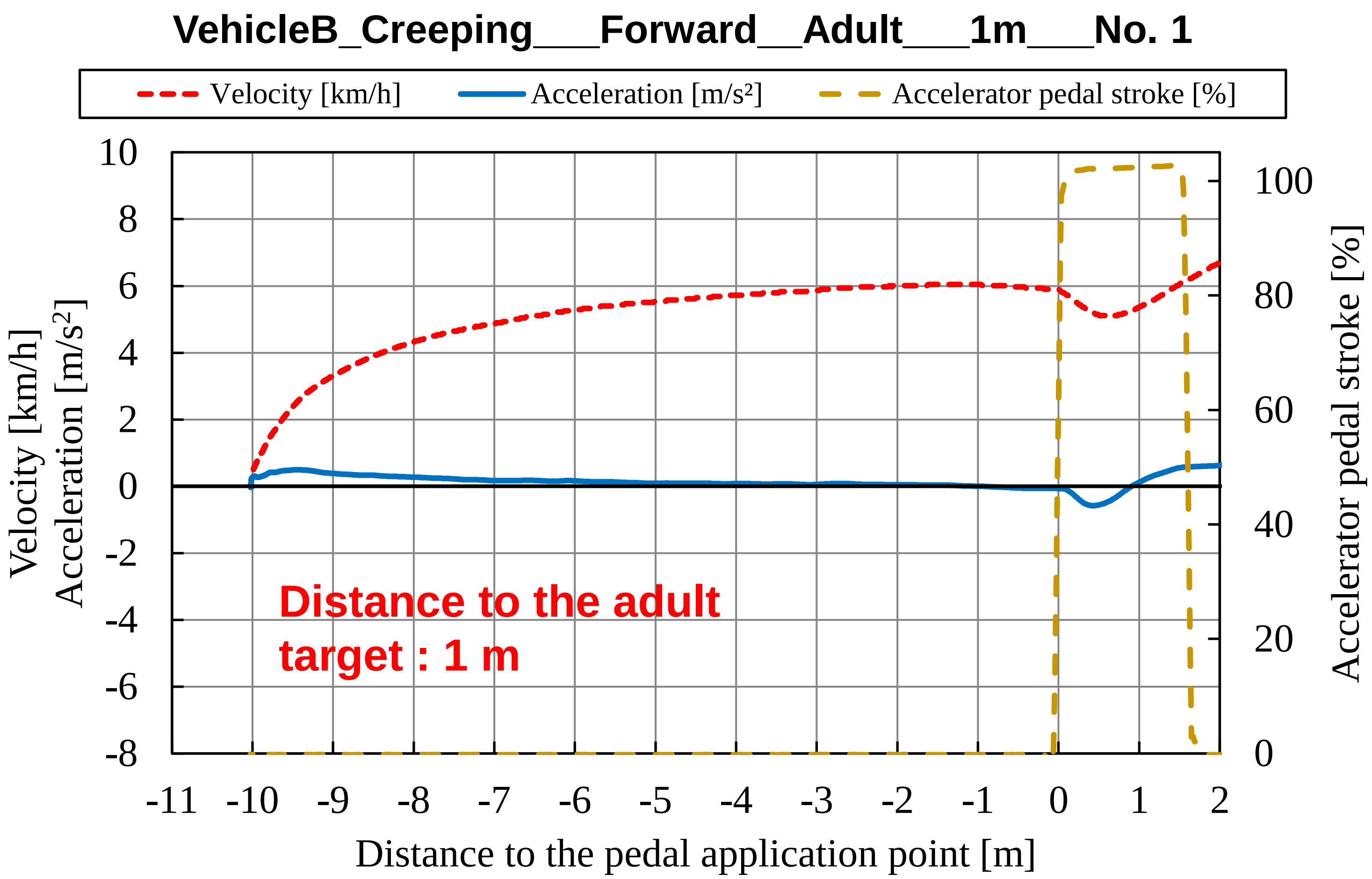
- Collision with the target was avoided by braking control.

Experimental result (Examples of detail data, Forward direction)



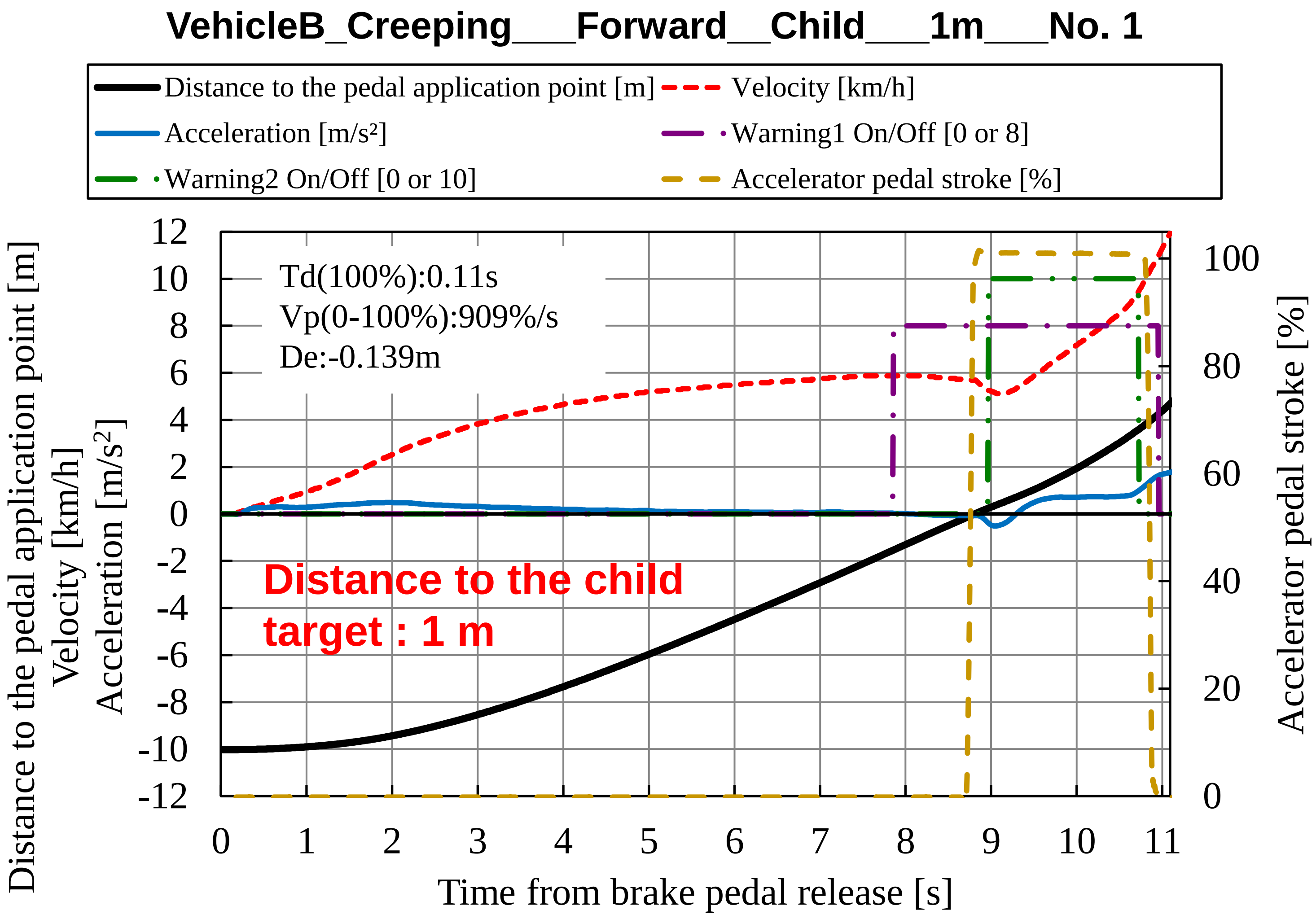
- Acceleration was controlled during accelerator pedal application.
- No higher deceleration was observed.
- It is considered that the warning 1 was shown by AEBS, and it is not clear whether the warning 2 was shown by AEBS or ACPE.

Experimental result (Examples of detail data, Forward direction)



- Collision speed was 5.4 km/h (lower than creeping speed).

Experimental result (Examples of detail data, Forward direction)



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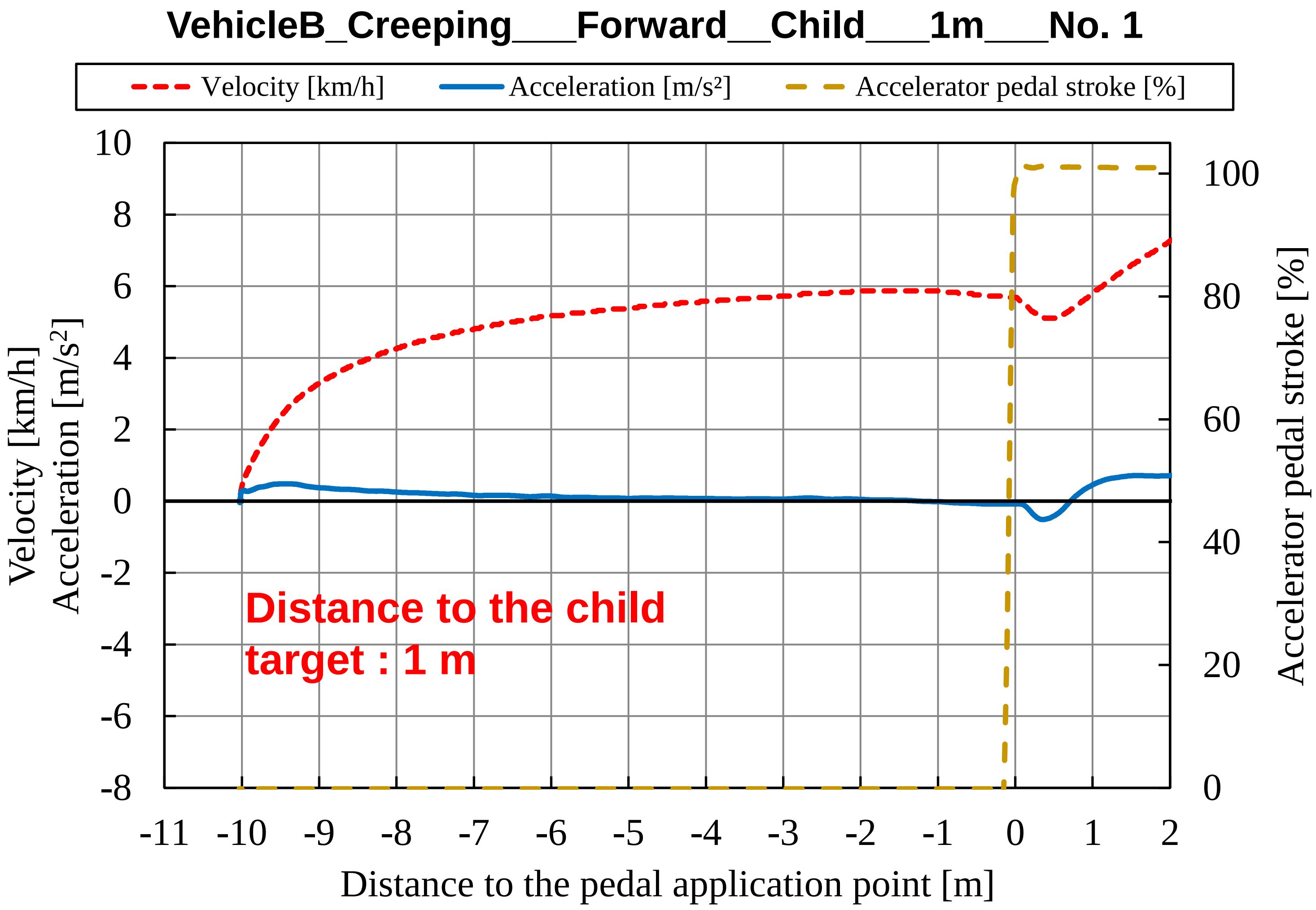
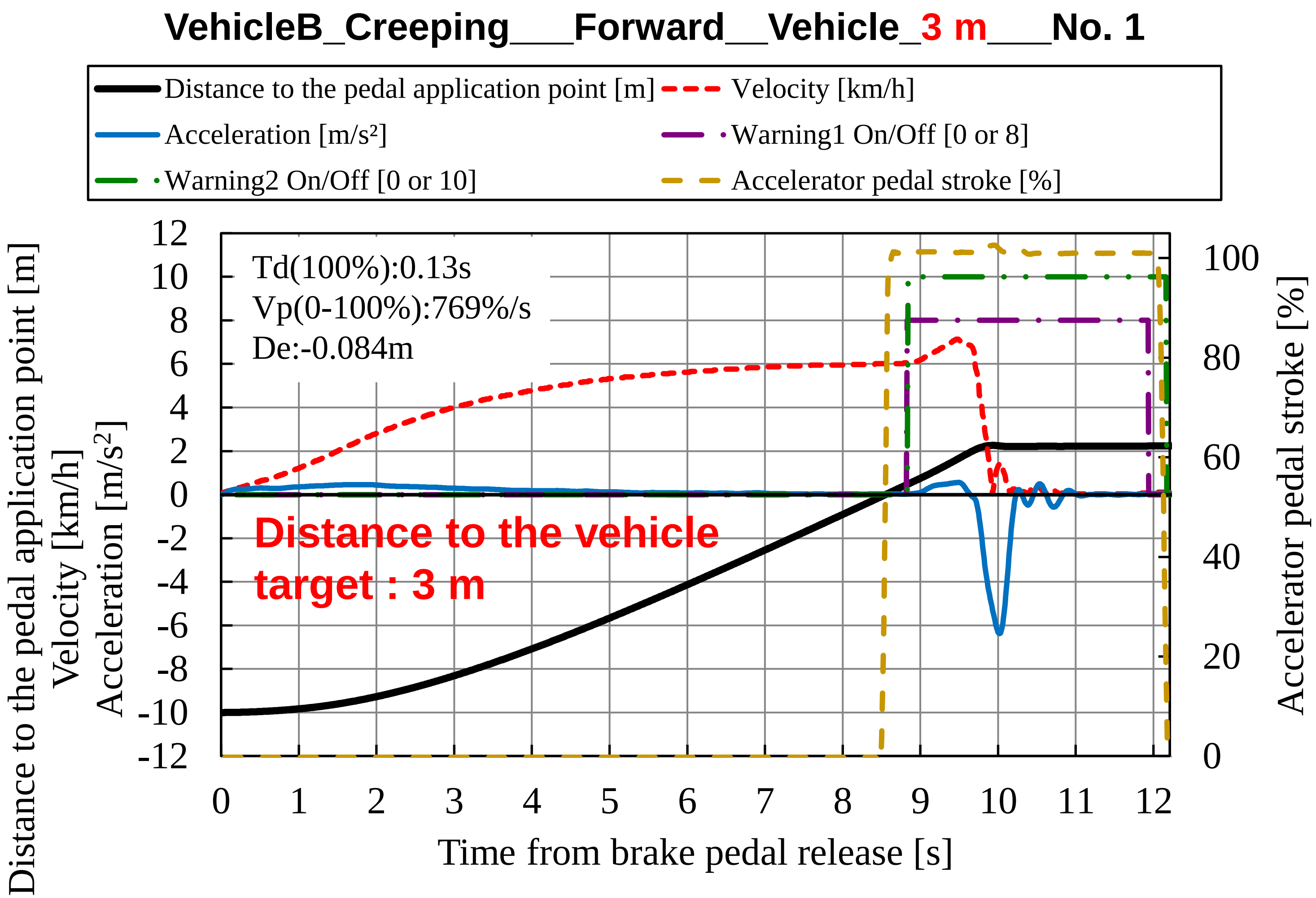
Experimental result (Examples of detail data, Forward direction)



- Collision speed was 5.8 km/h (almost same as creeping speed).

Experimental result (Examples of detail data, Forward direction)

- An example of longer distance from the accelerator pedal application to the target -

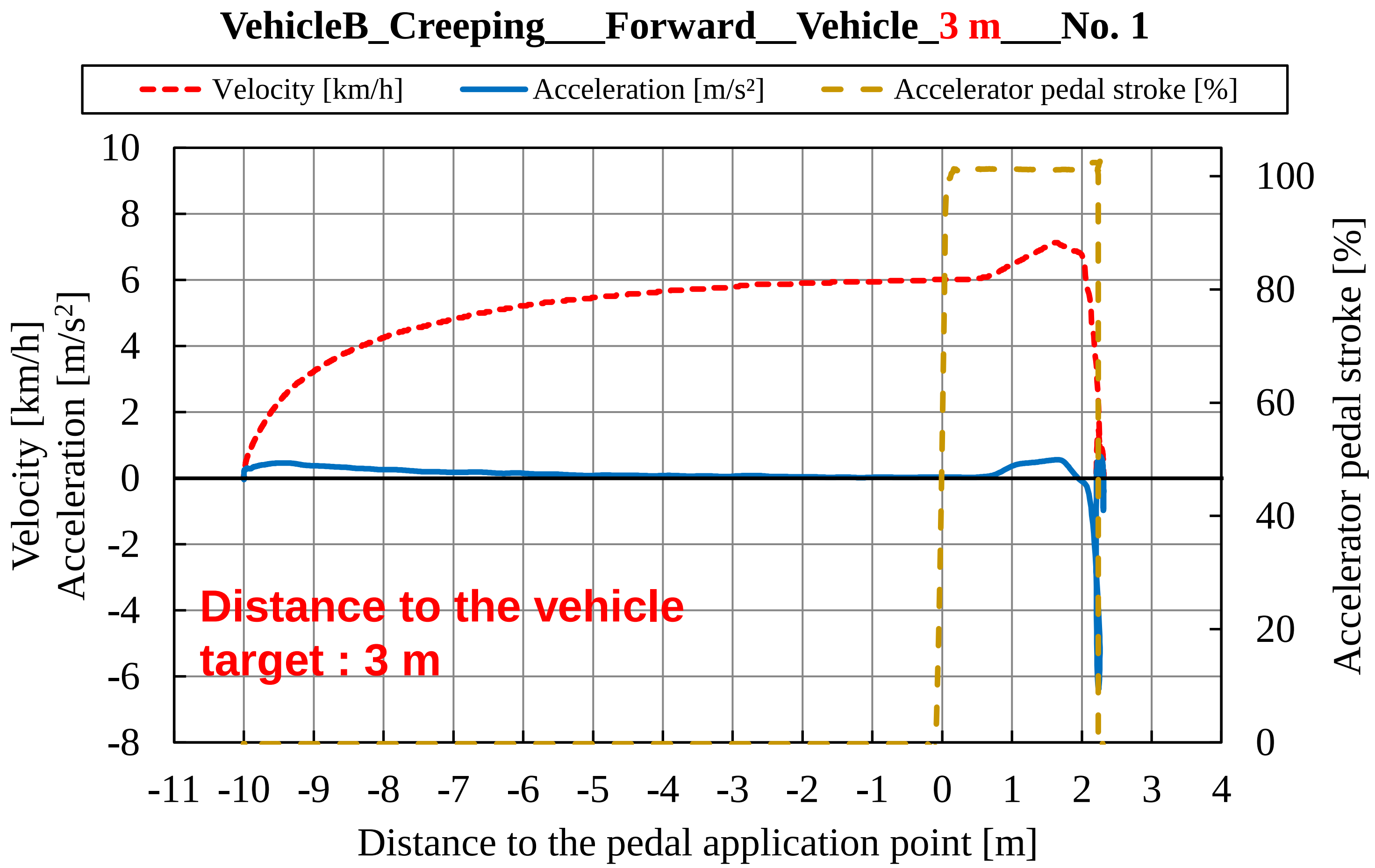


- Acceleration control was continued for more than 2 sec..
- The vehicle was decelerated and completely stopped.
- It is considered that braking control was carried out by ACPE, because both the warning 1 and the warning 2 were begun approximately 0.3 sec. after the start of accelerator pedal application.

⇒It is considered that longer distance is effective in order to avoid interference with AEBS.

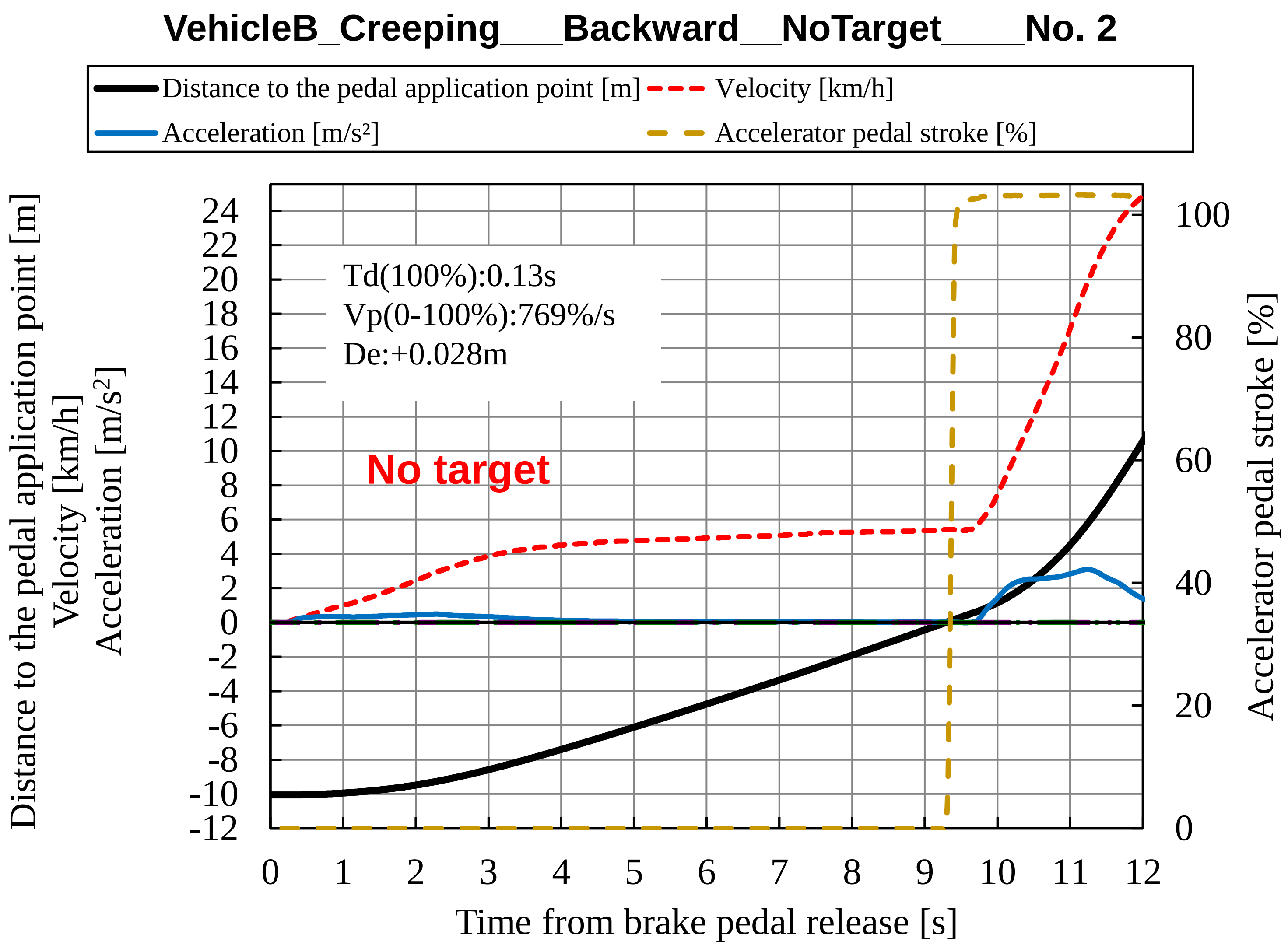
Experimental result (Examples of detail data, Forward direction)

- An example of longer distance from the accelerator pedal application to the target -



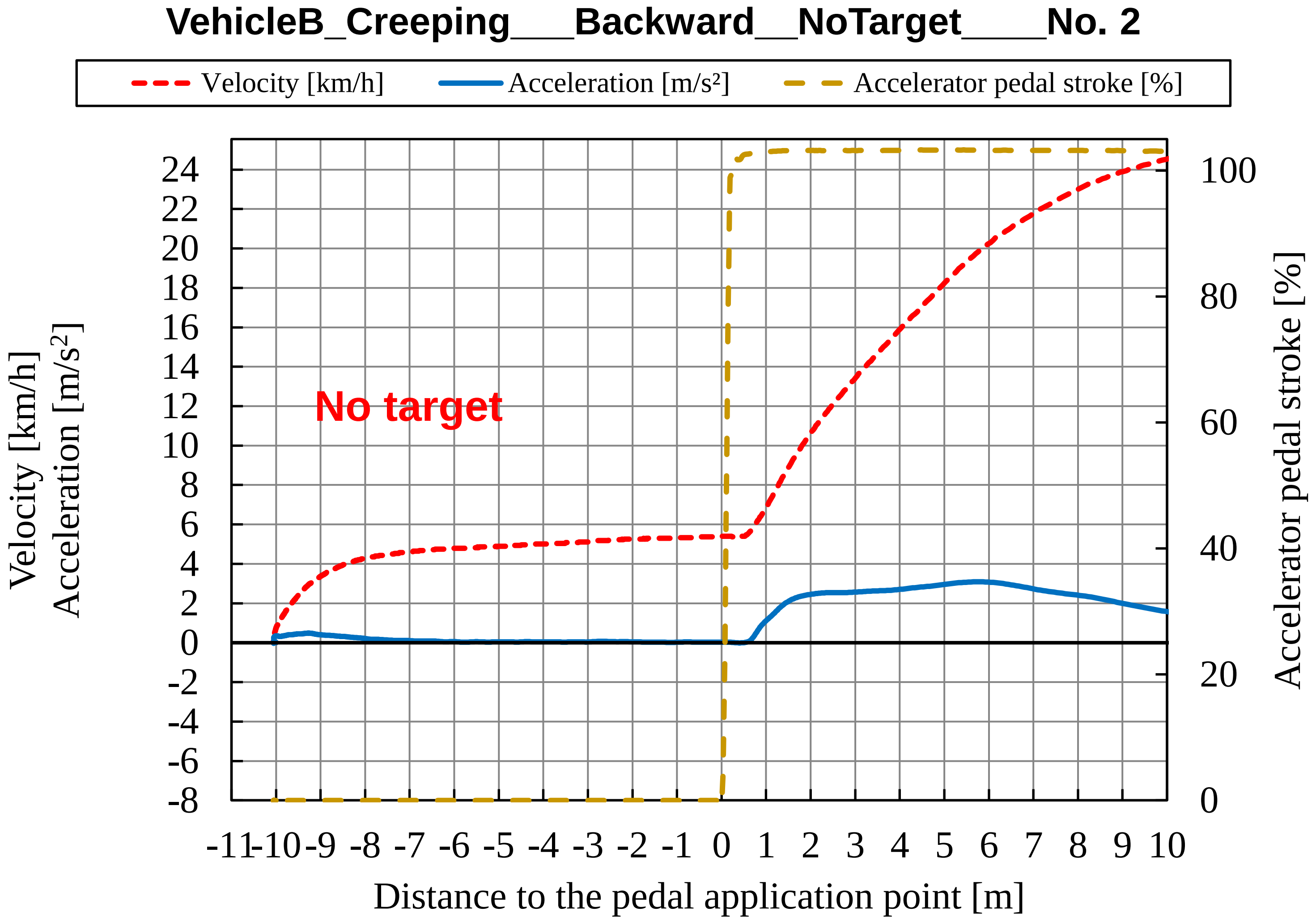
- Collision with the target was avoided by braking control.

Experimental result (Examples of detail data, Backward direction)



- Maximum acceleration of the was approximately 3.0 m/s^2 in the condition of "no target".

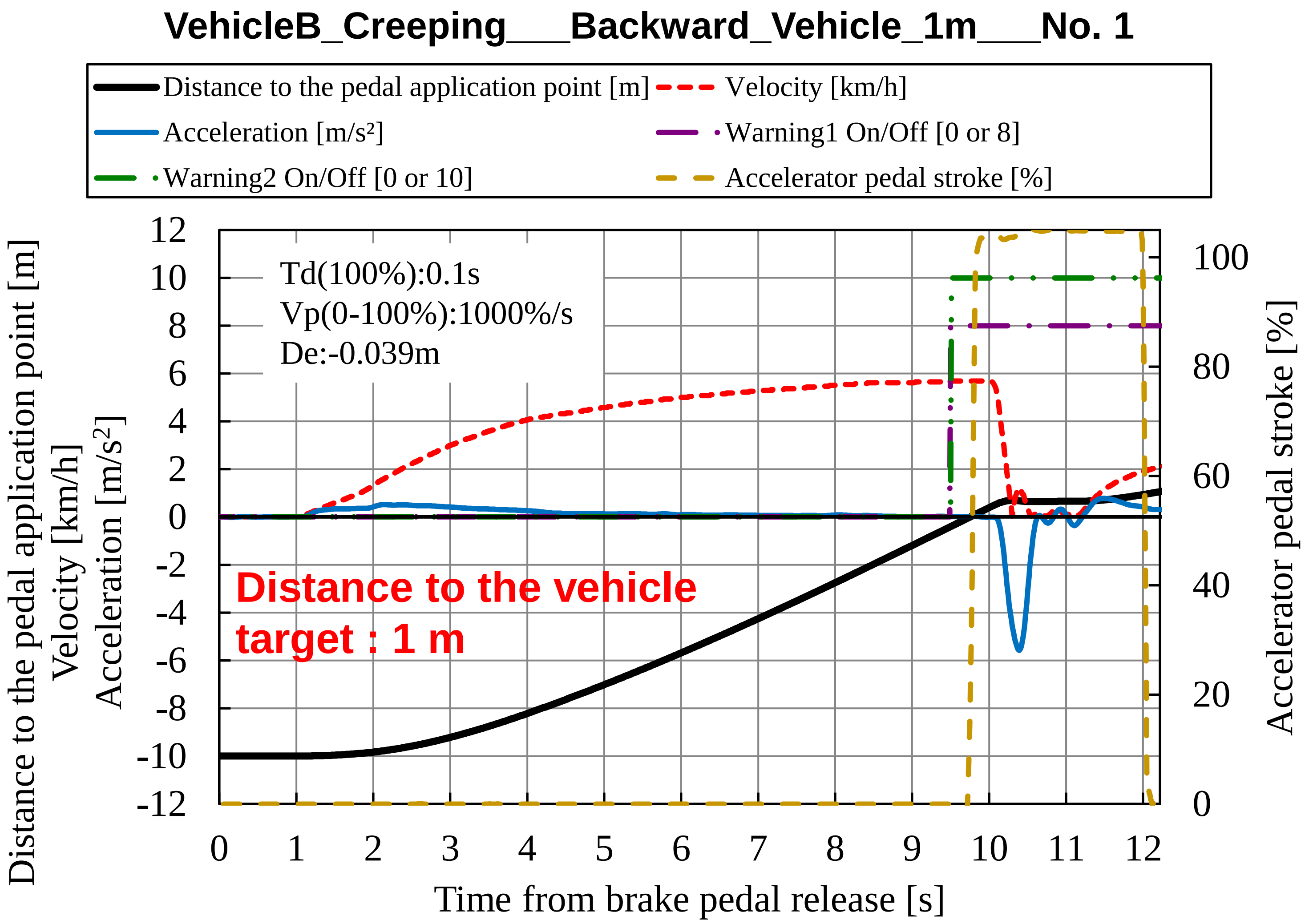
Experimental result (Examples of detail data, Backward direction)



- Creeping speed was approximately 5.4 km/h, just when accelerator pedal was applied. And then, velocity reached almost steady value.
- The vehicle didn't accelerate almost for approximately 0.5 m just after the accelerator pedal was applied.

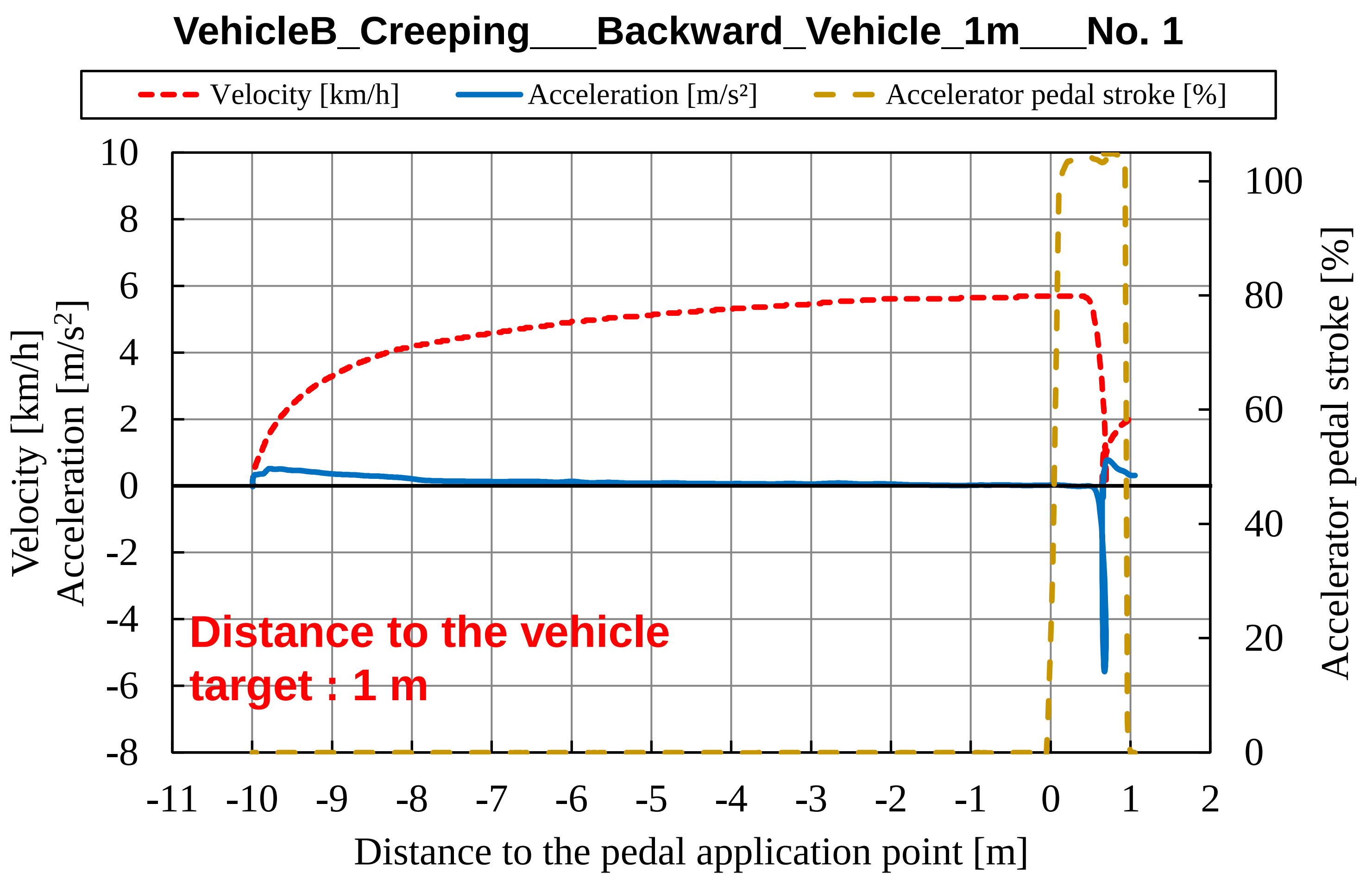
⇒**Distance from accelerator pedal application point to the target should be considered carefully.**

Experimental result (Examples of detail data, Backward direction)



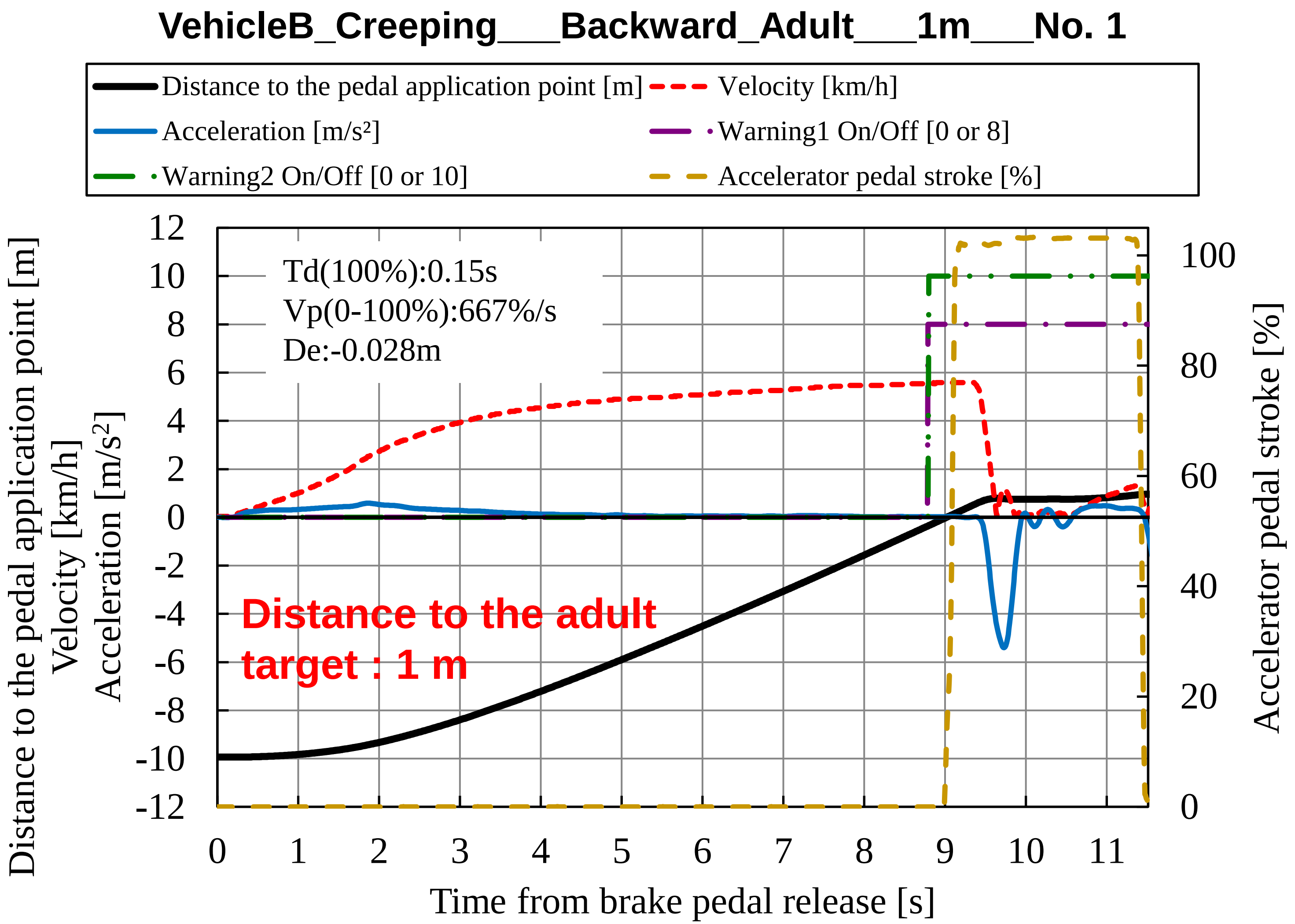
- Acceleration control was continued for more than 2 s.
- The vehicle was decelerated and completely stopped.
- It is difficult to distinguish whether braking control was carried out by AEBS or ACPE, because both the warning 1 and the warning 2 were begun approximately 0.3 sec. before the start of accelerator pedal application.

Experimental result (Examples of detail data, Backward direction)



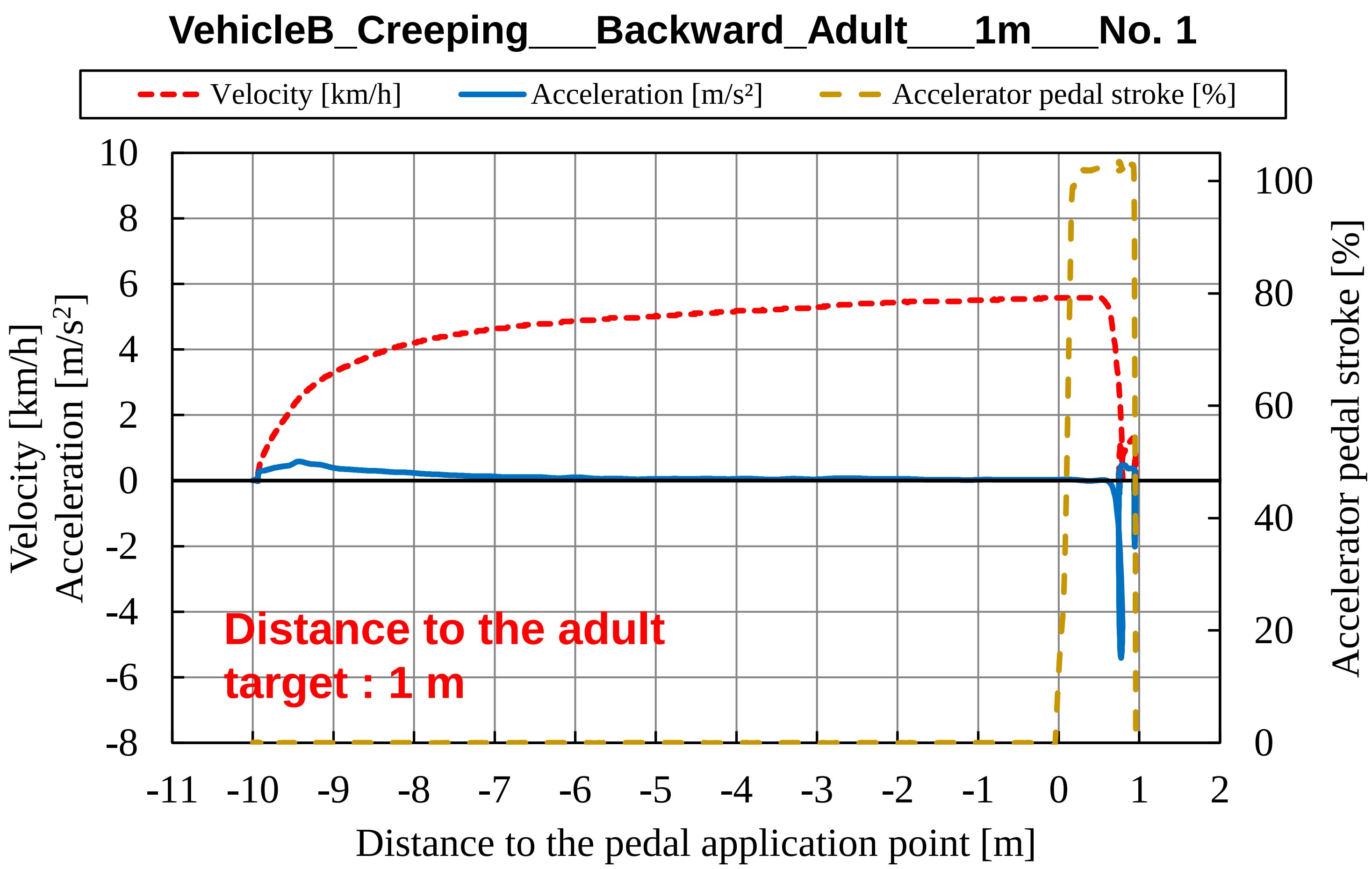
- Collision with the target was avoided by braking control.

Experimental result (Examples of detail data, Backward direction)



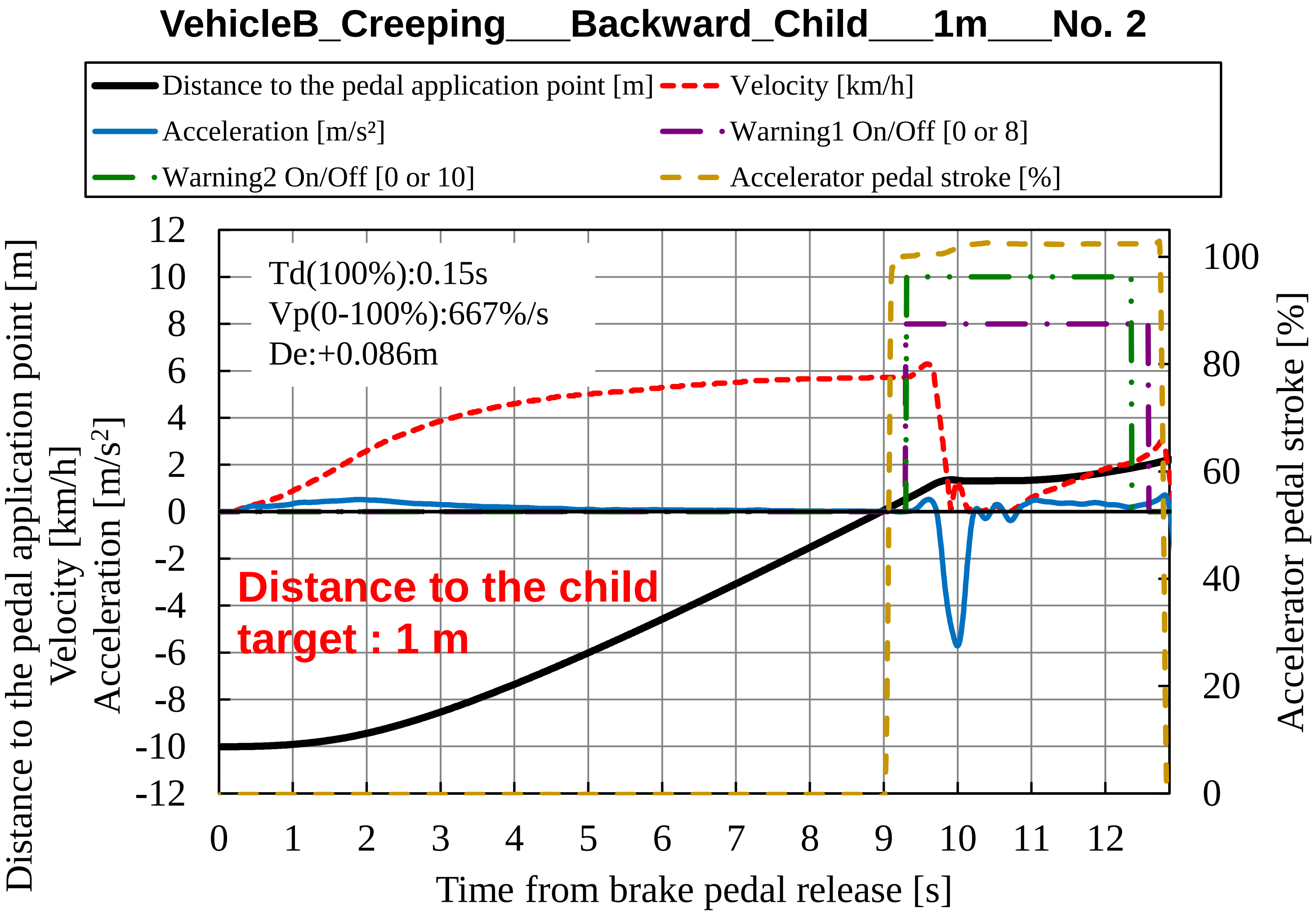
- Acceleration was controlled for more than 2 sec..
- The vehicle was decelerated and completely stopped.
- It is difficult to distinguish whether braking control was carried out by AEBS or ACPE, because both the warning 1 and the warning 2 were begun approximately 0.2 sec. before the start of accelerator pedal application.

Experimental result (Examples of detail data, Backward direction)



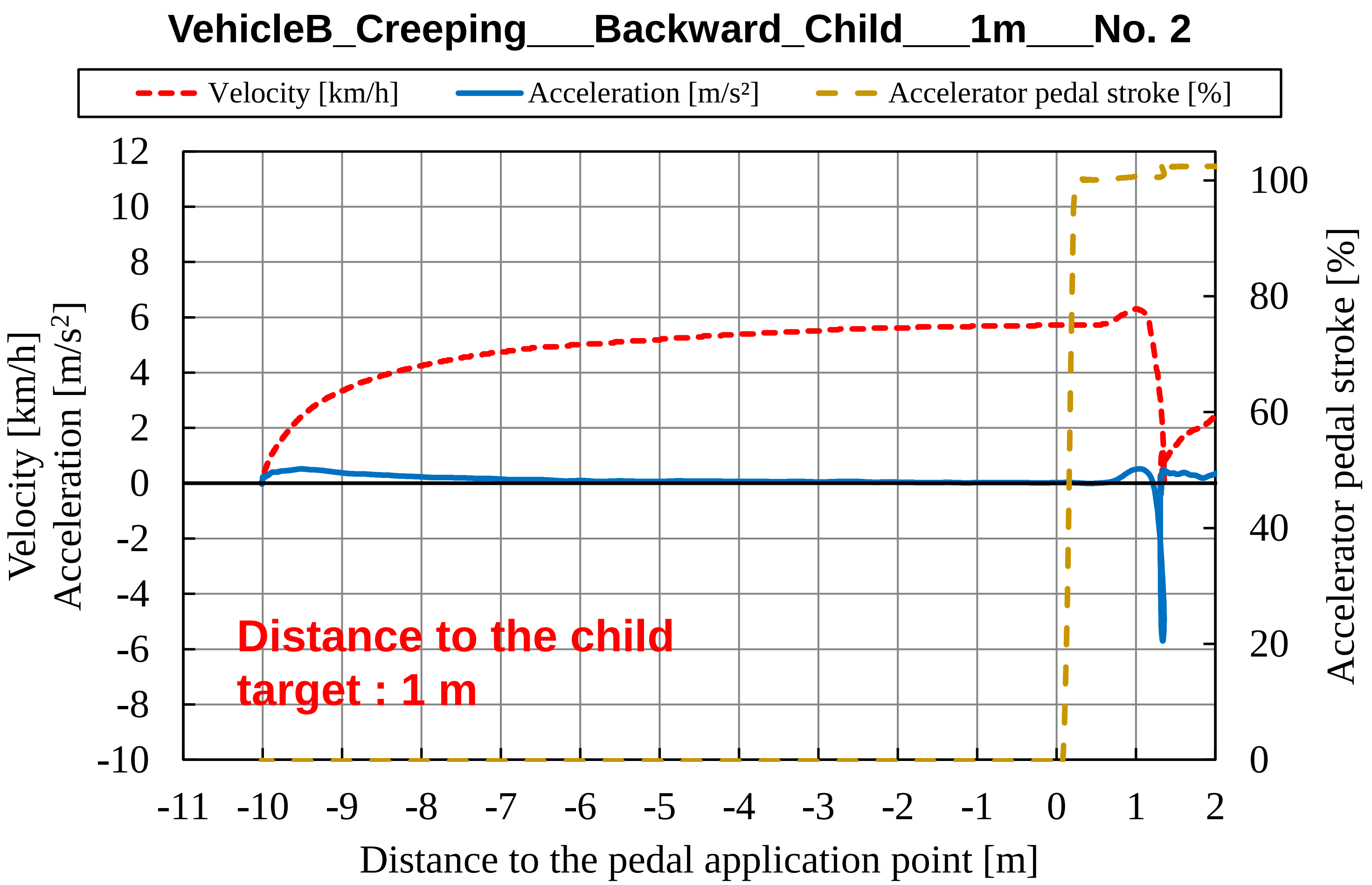
- Collision with the target was avoided by braking control.

Experimental result (Examples of detail data, Backward direction)



- Acceleration was controlled for more than 2 sec..
- The vehicle was decelerated and completely stopped.
- It is considered that braking control was carried out by ACPE, because both the warning 1 and the warning 2 were begun approximately 0.3 sec. after the start of accelerator pedal application.

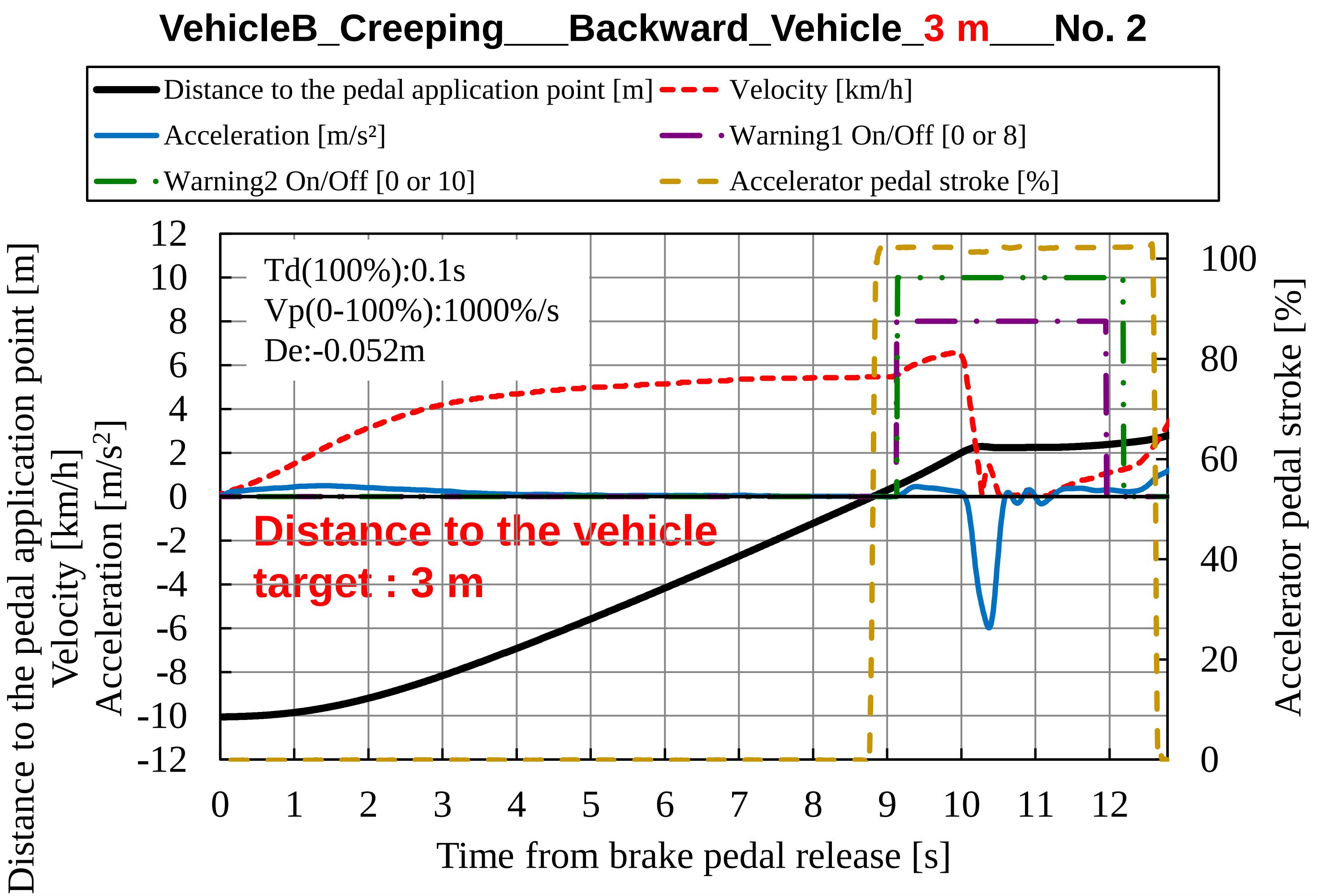
Experimental result (Examples of detail data, Backward direction)



- Collision speed was 6.3 km/h (0.6 km/h higher than creeping speed).
- Just after a collision, the vehicle was completely stopped.

Experimental result (Examples of detail data, Backward direction)

- An example of longer distance from the accelerator pedal application to the target -

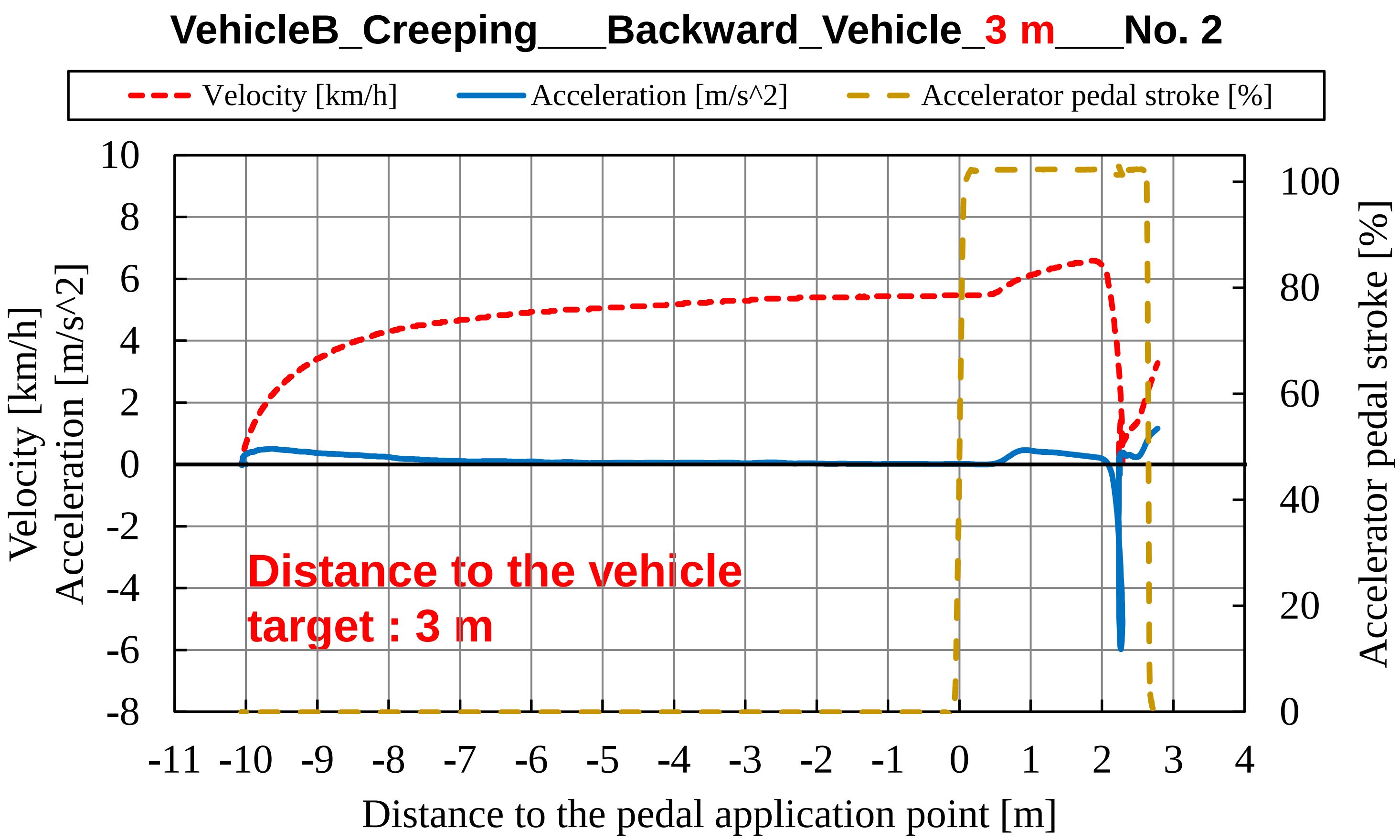


- Acceleration control was continued for more than 2 sec..
- The vehicle was decelerated and completely stopped.
- It is considered that braking control was carried out by ACPE, because both the warning 1 and the warning 2 were begun approximately 0.4 sec. after the start of accelerator pedal application.

⇒It is considered that longer distance is effective in order to avoid interference with AEBS.

Experimental result (Examples of detail data, Backward direction)

- An example of longer distance from the accelerator pedal application to the target -



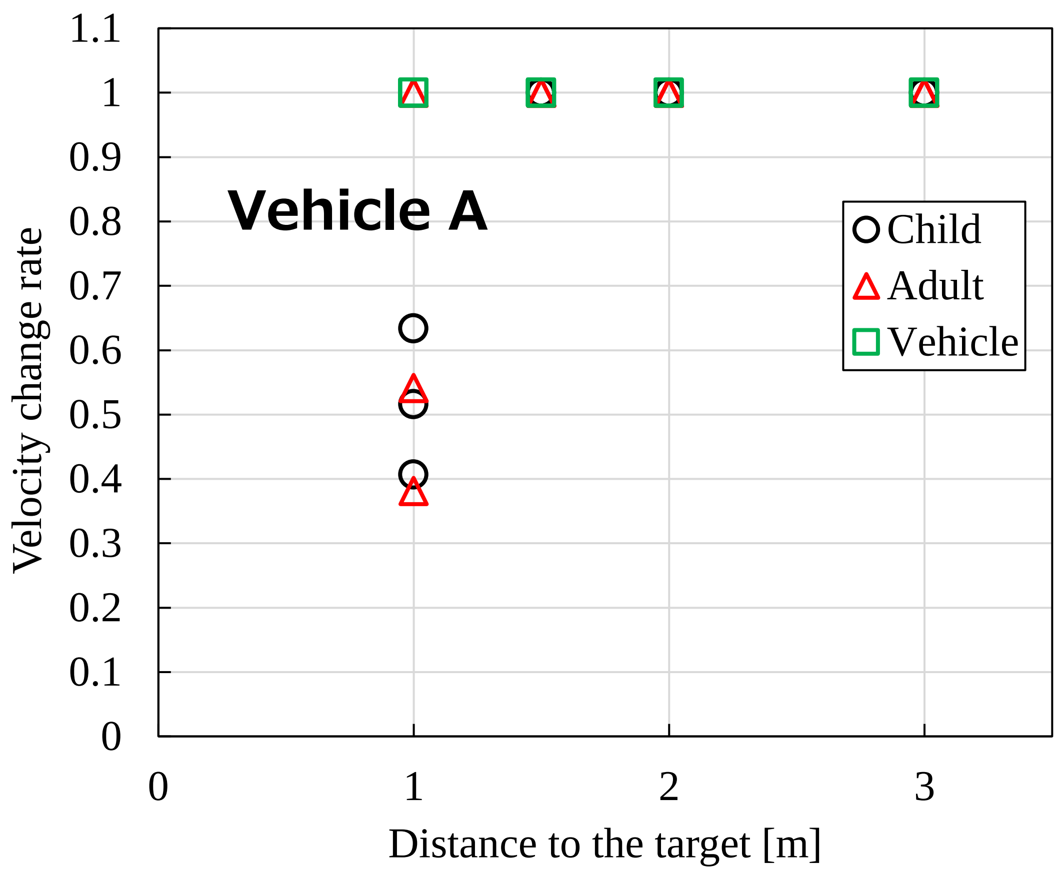
- Collision with the target was avoided by braking control.

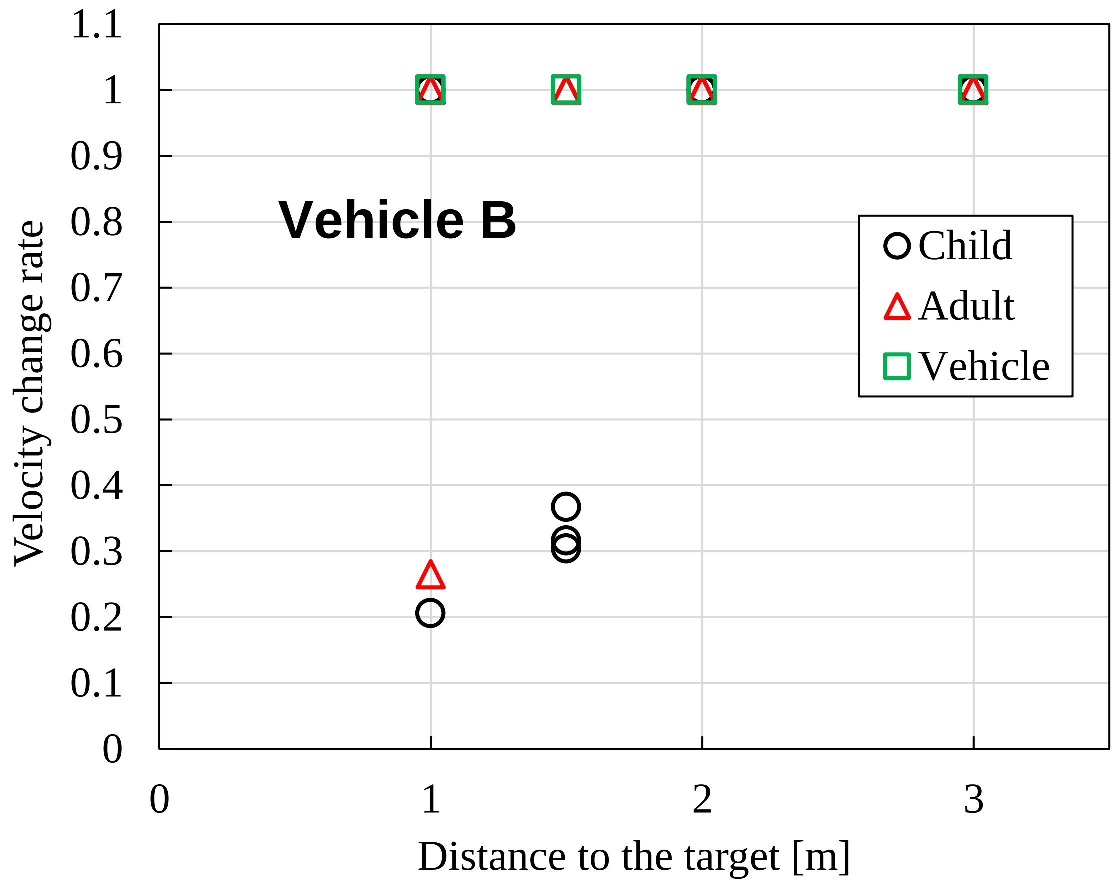
Summary of the investigation

- In the creeping test procedure, **in almost all the test cases, acceleration control was activated**. And in many of the test cases, the vehicle was completely stopped and collision with the target was avoided.
- **Higher deceleration by emergency braking control before the accelerator pedal was applied was not observed** even if the distance to the target was 1 m. However, in the cases of 1 m, **it is not clear whether braking control was carried out by AEBS or ACPE**, because the warning 1 (and the warning 2) was begun just before accelerator pedal application. On the other hands, in cases of 3 m, the warnings were begun just after accelerator pedal application.
- **The vehicle didn't accelerate almost for approximately 0.5 m to 0.6 m just after the accelerator pedal was applied**.
- For the creeping test procedure, it is considered that **longer distance to the target (ex. 3 m) is effective** for appropriate ACPE performance evaluation.

Summary of data of vehicle A and vehicle B (velocity change rate)

Creeping test procedure, Forward direction

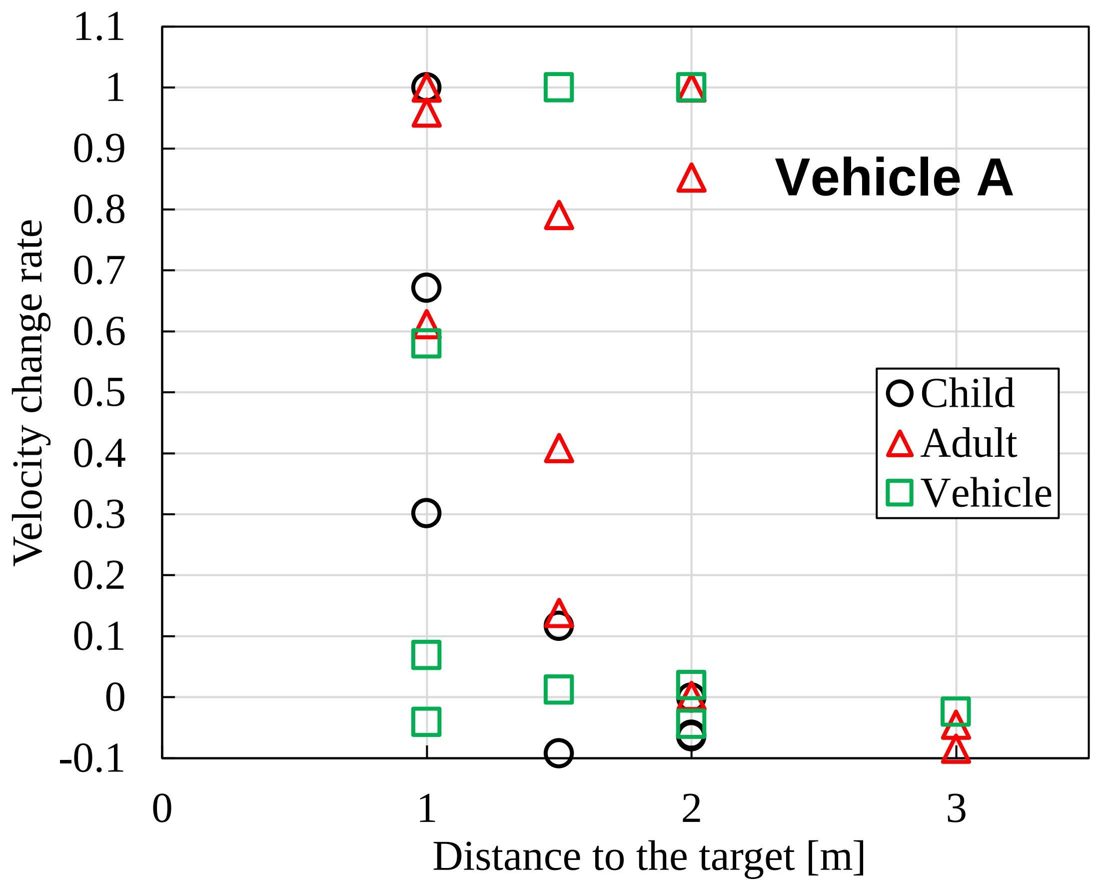


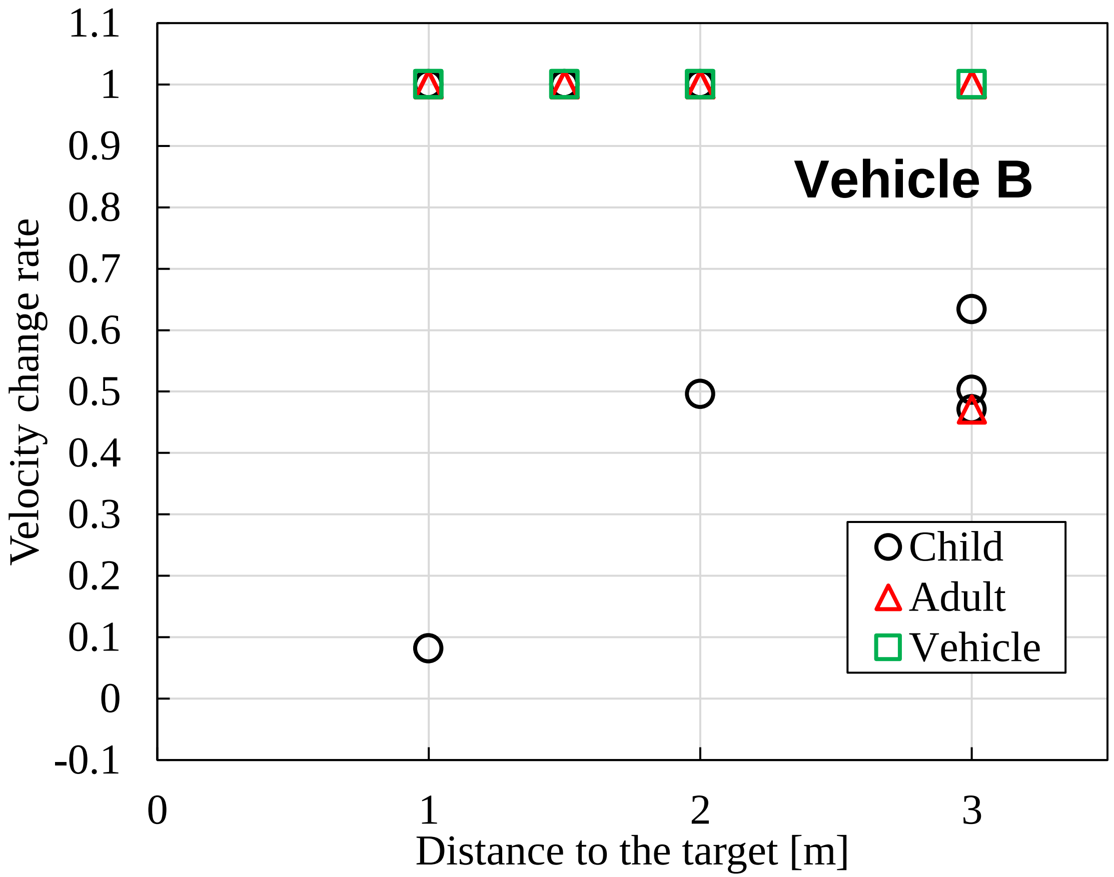


Above data doesn't represent ACPE performance of the creeping test procedure in the whole of Japanese vehicles.

Summary of data of vehicle A and vehicle B (velocity change rate)

Creeping test procedure, Backward direction





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