Driver Incapacity Response System

Advanced (Pulling-Over) Type

Local road Edition

Basic Design Guide

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1. Introduction

1.1 Positioning of the Basic Design Guide

This Basic Design Guide summarizes the technical requirements and considerations to give in view of the traffic environment of local roads in designing a system to respond to driver incapacity on local roads, advanced type ("Driver Incapacity Response System, Advanced (Pulling-Over) Type, Local Road Version ("the System")") that evacuates the vehicle to a safer place such as the shoulder or roadside. This Guide will be revised from time to time as appropriate in consideration of future technical development and social situation.

1.2 Functions of the Driver Incapacity Response System, Advanced Type

If the driver suddenly became incapacitated, or unable, to continue driving safely due to a sudden change in their physical condition ("driver incapacity"), the System, on behalf of the driver, pulls the vehicle over as close as possible to the shoulder or roadside and stops it as an emergency response.

The functions of the System are primarily to drive, slow down, and stop the vehicle within the same lane, but include also a function to change lanes and stop the vehicle in the leftmost lane and a function to bring the vehicle to a stop, avoiding places that may expose it to the risk of serious secondary accidents.

Explanatory Note

The System is intended to be activated *not to* deal with human errors committed by the driver in normal condition, *but to* ensure emergency response to a sudden change in their physical condition, rendering them unable to continue driving safely ("driver incapacity).

To prevent the vehicle from running out of control following the driver's incapacity and to keep the driver, passengers, and other road users away from the risk of a collision, the System is provided with an extended function to slow down and stop the vehicle in a place as safe as possible, while notifying other road users of what is happening and urging them to take appropriate action to avoid the risk. It should be noted that the System is activated strictly as an emergency response to the driver's incapacity and that, as such, depending on the conditions under which it is activated, the vehicle may come in violation of the Road Traffic Act and that, even with the System, accidents may prove inevitable in certain situations: the System definitely isn't a 100 % foolproof.

Systems that do not stop the vehicle are outside the scope of this Basic Design Guide. In other words, systems that are designed to stop the vehicle by crashing it into something or by having a passenger apply the brake on behalf of the driver are not covered by this Guide.

The driver incapacity response system specified in this Guide is one that brings the vehicle to a stop as close as the roadside or shoulder while giving consideration to the safety of other vehicles, etc. in the vicinity. In order to ensure the safety of the occupants and reduce the time for evacuation and rescue, the System is designed to allow the vehicle to continue driving within a certain time and distance and to stop at the roadside or shoulder to the extent the requirements specified in this Guide are met.

When it proves difficult to pull the vehicle over to the roadside or shoulder, the System shifts to the Function to Slow Down and Stop the Vehicle. This leaving the vehicle at a stop in the lane, it is desirable, to the extent the rescuers confirm that the vehicle is safe under control of the System, for them to deactivate the System quickly and move it to the roadside or shoulder that is wide enough.

1.3 Scope of Application

(i) Driver incapacity the System covers

The System covers sudden changes in physical condition that are difficult for the driver to predict in advance, or driver incapacity, such as sudden cerebrovascular disease, cardiac disease, gastrointestinal disease, and fainting.

The System is not intended to address unwellness or illness caused by alcohol consumption, poor health management, fatigue, illness, drugs, etc. that can be predicted in advance. However, it does not exclude such unwellness or illness from the subject of response.

Explanatory Note

Article 65 of the Road Traffic Act stipulates, " It is prohibited for any person to drive a vehicle or streetcar while under the influence of alcohol." Article 66 of the same Act stipulates, " It is prohibited for any person to drive a vehicle or streetcar while in a state in which overwork, illness, the influence of drugs, or any other circumstances is likely to make the person unable to drive safely, beyond as provided in section (1) of the preceding Article."

It is the driver's responsibility to effectively manage their health. They are supposed to be in good condition while driving.

The sentence, "However, it does not exclude such unwellness or illness from the subject of response." is added because it is technically difficult to determine the difference between a predictable unwellness or illness and sudden incapacity that is difficult to predict in advance.

(ii) Vehicles to be covered

The Guideline applies to motor vehicles (excluding motorcycles and mopeds).

Explanatory Note

Motorcycles and mopeds are excluded from the scope of application of this Guide, considering the risk of the driver in such incapacity falling from the bike and the System not functioning effectively.

(iii) Roads to be covered

The Guideline applies to local roads.

1.4 Definition of Terms

(1) Driver incapacity

Sudden changes in physical condition that are difficult for the driver to predict in advance. Illness or incapacity that can be predicted in advance are not included in driver incapacity.

(2) Driver Incapacity Response System

A system that detects driver incapacity and stops the vehicle on their behalf.

(3) Driver Incapacity Response System (Slow Down and Stop Type)

A type of the System that slows down and stops the vehicle upon detecting driver incapacity. Includes those which control steering to prevent it from leaving the lane or the road.

Explanatory Note

The Driver Incapacity Response System (Slow Down and Stop Type) does not include systems which control steering for the purpose of having the vehicle change lanes or move to a stop on the shoulder, etc. In addition, the System of this type does not necessarily judge whether the place the vehicle stops at is a suitable location for stopping.

The technical requirements and considerations to be given for the Driver Incapacity Response System (Slow Down and Stop Type) are prescribed in the Basic Design Guide to Driver Incapacity Response Systems (Slow Down and Stop Type).

(4) Driver Incapacity Response System, Advanced Type ("the System")

A type of the System that, upon detecting driver incapacity while driving on a local road, takes control of the vehicle, slows it down and pulls it over to the shoulder or outer roadside.

The primary function of System is to slow down and stop the vehicle while keeping it in the same lane. The system's functions also include the one to change lanes and stop the vehicle in the leftmost lane, and the one to bring the vehicle to a stop avoiding places that may expose it to the risk of serious secondary accidents.

(5) Control

The System's ability to automatically control the movement of the vehicle by controlling the vehicle's speed only, controlling its steering only, or controlling both the vehicle's speed and steering.

(6) Passengers

The crew and passengers, excluding the driver.

Explanatory Note

The System does not distinguish between passengers in private vehicles and those in commercial vehicles, calling them all "passengers".

(7) Side

The area present to the left of the vehicle between the extensions of the front edge and

the rear edge of the vehicle.

(8) Diagonally behind

The area diagonally behind the vehicle to left

(9) Diagonally ahead

The area diagonally ahead of the vehicle to left

(10) Changing lanes

The act of moving the vehicle from the lane in which it is currently traveling to the next lane to the left, crossing the lane marking.

(11) Changing the direction

The act of moving the vehicle from the lane in which it is currently traveling to the left, crossing the lane marking or of moving the vehicle to the shoulder or roadside crossing the outer lane marking. On a road where there are no lanes, the act of moving the vehicle sideways.

(12) Sideways

The direction perpendicular to the direction of travel.

(13) Expressways

National expressways and motor highways.

(14) Local roads

Roads other than national expressways and motor highways.

(15) No-stopping zone

A place where it is desirable to avoid entering or stopping in because they may expose the vehicle to the risk of serious secondary accidents. Typical examples include intersections and railroad crossings.

(16) Roadside

The shoulder or side strip on the left side of the road, or the left edge of the road.

(17) Passenger-activated type

A type of the System that starts checking for driver incapacity when a passenger activates the detection system. The mode of activation should not be limited to the person pressing a button with a finger or a hand, but include all types of activation mechanisms.

(18) Driver-activated type

A type of the System that starts checking for driver incapacity when the driver activates the detection systems. The mode of activation should not be limited to the driver pressing a button with a finger or a hand, but include all types of activation mechanisms.

(19) Automatic type

A type of the System of which a detection system automatically monitors the driver's posture, etc. through sensors, etc. and detects driver incapacity

(20) Automatic driver incapacity detection system

A system that automatically detects driver incapacity through sensors, etc.

(21) Main switch

A toggle switch that makes the System operable or inoperable.

(22) Activation

The act of activating functions to alert people or control the vehicle.

(23) Activation switch

A switch that gives a trigger signal to alert people or control the vehicle. Includes the passenger-activated switch or driver-activated switch.

(24) Deactivation switch

A switch with which the driver cancels functions to alert people or to control the vehicle.

(25) Alert

The act of notifying people who are affected by the System's operation of what the System is doing. Besides visual and auditory warnings, the ways this is done includes tactile alerts (e.g., steering wheel vibration) for the driver and body sensory alerts (e.g.,

gradual slowing down) for the driver and passengers.

Explanatory Note

Weak braking is felt by the driver and passengers as a bodily sensation of the vehicle gradually slowing down.

(26) The vehicle

The vehicle equipped with the System.

(27) Other vehicles

Motor vehicles for the purposes of the Road Traffic Act other than vehicles equipped with System, mopeds, and bicycles.

(28) Motorcycles

Large motorcycles and standard motorcycles for the purposes of the Road Traffic Act.

(29) Mopeds

Mopeds for the purpose of the Road Traffic Act.

(30) Outside road users

People in the vicinity of a vehicle equipped with System, including pedestrians, cyclists, and other motor vehicles.

(31) Activation alert

An alert to the driver or the passenger who turned the activation switch on notifying that the System has been activated and reminding the driver to hit the deactivation switch if they find the control unnecessary.

(32) Warning alert

An alert to passengers and outside road users that the System is about to take control of the vehicle.

(33) “Control activated” alert

An alert to the drivers, passengers, and outside road users that the vehicle is under the control of the System (including being parked).

(34) Override

The act of the driver or passenger adjusting braking, driving, steering, etc., in priority over the System.

2. Overview of Functions

2.1 Functions of the System

The System consists of:

- The functions to detect driver's incapacity

- The functions to evacuate the vehicle to the shoulder, etc.

- The functions to notify people of what the System is doing

The functions to detect driver's incapacity includes:

- Automatic type

- Driver-activated type

- Passenger-activated type

These are used alone or in combination.

The functions to evacuate the vehicle to the shoulder, etc. include:

(i) Function to drive the vehicle in its lane

(ii) Function to have the vehicle change lanes

(iii) Function to pull the vehicle over to the roadside

(iv) Function to slow down and stop the vehicle

(v) Function to avoid stopping the vehicle in no-stopping zones

using (i) and (iv) as primary functions and any of (ii), (iii), and (v) alone or in combination as additional functions.

The functions to notify people of what the system is doing consist of:

- Alert to the driver

- Alert to passengers

- Alert to outside road users

Explanatory Note

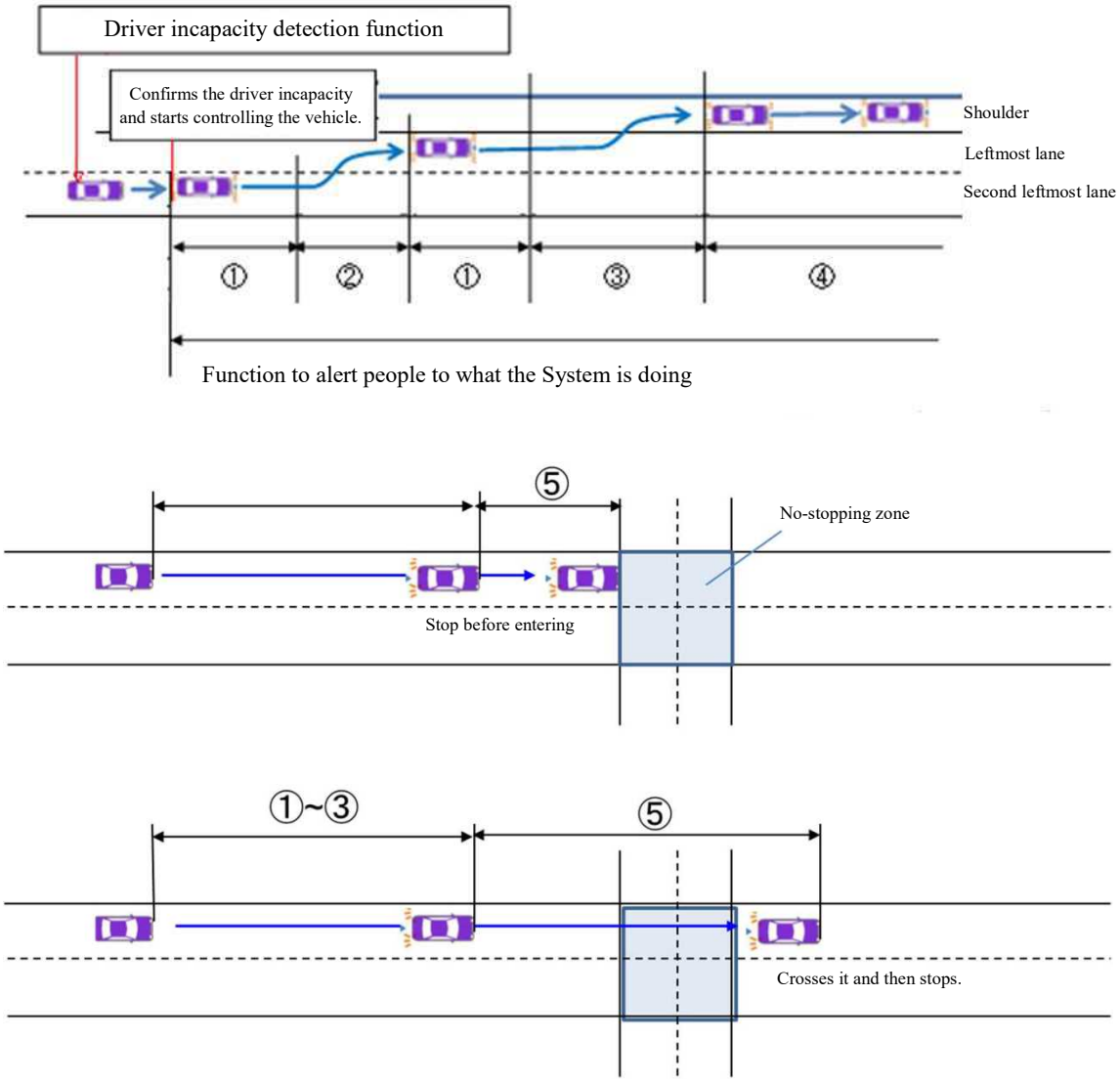
If the system detects the driver incapacity while driving on a local road and starts controlling the vehicle, it then confirms the safety of the left side lanes, changes lanes toward the leftmost lane, keeps running while searching for a roadside space good to stop at such as the shoulder, and after confirming safety, pulls the vehicle over to the shoulder or roadside and stops there.

The system also has a function to detect no-stopping zones such as at intersections and railroad crossings, stop before entering them or else passes them quickly taking safety precautions.

Some local roads have sections without shoulders, and in such areas, it is considered safer to pull the vehicle over to the left side of the road, so the system pulls the vehicle over to the left of the leftmost lane and stop it there. Where the shoulder is provided but too narrower to park the vehicle, the system pulls the vehicle over to the left side of the shoulder for the same safety reasons.

It is assumed that, other than the systems having all the functions shown in Fig. 1, the System will be offered in a great variety of types, including a system of the type that, if activated while travelling the leftmost lane, pulls the vehicle over to the shoulder as its function *to evacuate the vehicle to the shoulder, etc.*, but, if activated while traveling other lanes, stops the vehicle then and there through its function *to slow down and stop the vehicle*, a system of the type that has a function to stop the vehicle avoiding places that may expose it to the risk of serious secondary accidents, or a system that, as a function to detect the driver incapacity, uses both the automatic detection type and the passenger-activated detection type in combination.

Regarding the function to stop the vehicle avoiding places that may expose the vehicle to the risk of serious secondary accidents, it is desirable that this function be made mandatory as technology advances in the future in order not to extend the damage.



Function to evacuate the vehicle to the shoulder, etc.

(i) Function to drive the vehicle in its lane

(ii) Function to have the vehicle change lanes

(iii) Function to pull the vehicle over to the roadside

(iv) Function to slow down and stop the vehicle

(v) Function to avoid stopping the vehicle in no-stopping zones

Figure 1: Functions of the System

Explanatory Note

Figure 2 shows how this Basic Design Guide is structured.

Figure 2: Structure of this Basic Design Guide

2.1.1 Main switch

A main switch that allows the driver to turn the whole system on or off may be added. In such a case, the main switch must be on when the engine is started.

Explanatory Note

This is to allow the driver to turn the whole system on or off at will, as with other driver assistance systems.

“When the engine is started” means when the vehicle is ready to run, such as when the engine is started or when the motor system for driving an electric vehicle is started.

The main switch must be carefully designed in terms of its handling or location in order to prevent the System from being switched on or off accidentally. Examples include designing the main switch to be long-pressed or pressed twice.

2.2 Function to Detect Driver Incapacity

The Function to Detect Driver Incapacity includes Automatic Type, Driver-Activated Type, and Passenger-Activated Type, which may be used alone or in combination.

2.2.1 Automatic Type

This is a type of which a detection system automatically checks for and detects driver incapacity. Driver incapacity can be detected through vehicle’s behavior, driving behavior, or the driver’s conditions. The vehicle’s behavior includes wobbling, runaway, accidental contacts, etc. Driving behavior refers to unusual driving maneuvers and their input values. The driver's conditions include changes in driving posture and facial expressions (e.g., coma), changes in biological signs (e.g., heart rate, pulse, and body temperature), and the absence of driving maneuvers for a certain period of time.

Explanatory Note

The technical requirements and considerations to be given in designing a system that detects the driver incapacity from various signs, i.e., collapsed posture, closed eyes, and no steering maneuvers are prescribed in the Basic Design Guide for Automatic Driver Incapacity Detection System. Use the Basic Design Guide when developing and designing an automatic driver incapacity detection system based on the above detection parameters.

2.2.2 Driver-Activated Type

With this type of detection system, the driver themselves presses the activation switch, upon which the System starts checking for the driver's incapacity.

Explanatory Note

This type of detection system assumes cases where, feeling gradually losing consciousness and becoming incapacitated, the driver presses the activation switch. In cases where the driver suddenly passes out, they may be unable even to turn it on.

2.2.3 Passenger-Activated Type

With this type of detection system, any passenger who notices the driver's incapacity presses the activation switch, upon which the system starts checking for the driver's incapacity.

Explanatory Note

Even when the driver is unable to press the activation switch themselves, a passenger can press the switch when they notice the driver's incapacity, thereby notifying the system of the driver's incapacity. In addition to buses, this type of system can be used for all types of vehicles such as private vehicles and taxis, except for motorcycles.

2.3 Function to Evacuate the Vehicle to the Shoulder, etc.

This is a collective designation for all functions the System perform on behalf of the driver, after finding them incapacitated by the Function to Detect Driver Incapacity, to pull over the vehicle to the shoulder or roadside and park it there, such as Function to Drive the Vehicle in its Lane, Function to Have the Vehicle Change Lanes, Function to Pull the Vehicle Over to the Roadside, Function to Slow Down and Stop the Vehicle, and Function to Avoid Stopping the Vehicle in No Stopping Zones.

2.3.1 Timing to start controlling the vehicle

If there is no response from the driver for a certain period of time after the system detected their incapacity, the system takes control of the vehicle. In principle, the *certain period of time* must be 3.2 seconds or more. However, this time need not be set when the driver presses the activation switch themselves.

Explanatory Note

In consideration of false detection of driver incapacity, we find it appropriate to design the System to decide the driver is definitively incapacitated only when they give no response for a certain period of time after detecting their incapacity and to take control of the vehicle. If the driver is normal, they can always deactivate the System in response to the alert that it is about to take control of the vehicle, thereby canceling its taking control (See Section 2.4.1.1).

In principle, the period of time to be set is 3.2 seconds or more (as defined as the reaction time to a warning alert by the ASV Promotion Plan, Phase IV). It is desirable to set this period of time in such a way to allow the driver to respond to warning alerts in various driving situations (i.e. the time given to the driver within which to press the deactivation switch in response to the warning alert that the system is about to take control of the vehicle). This time period may be modified according to driving situations.

Further, this time period may be shortened if the driver can respond faster than in 3.2 seconds for such reasons as they have been sufficiently trained to press the deactivation switch more quickly.

In cases where a passenger accidentally presses the activation switch, or where an incapacity is falsely detected by the automatic driver incapacity detection system, it is desirable for the driver to be able to deactivate the switch before the System is activated, so setting certain period of time is mandatory for the Passenger-Activated Type and the Automatic Type.

With the Driver-Activated Type, the driver presses the activation switch intentionally, which makes it unnecessary to consider false detection. It is hence left to the discretion of the designer whether or not to set this period of time for this type.

However, in consideration of the case where the driver accidentally presses the activation switch, this period of time may be set even for the Driver-activated type.

2.3.2 Function to Drive the Vehicle in Its Lane

This function allows the activated System to, on behalf of the driver, drive the vehicle in its lane without departing the lane.

2.3.2.1 How to drive the vehicle in its lane

(1) Speed

To mitigate damage from collision with surroundings objects, the speed must be adjusted to an appropriate level while keeping the vehicle from departing its lane.

While the Function to Drive the Vehicle in Its Lane is activated, the vehicle speed must not exceed 10 km/h and, if it is over 10 km/h when the System took control, the vehicle must be slowed down to this speed.

This does not apply, however, if the same degree of safety is ensured as when the vehicle travels in its lane under the above speed limit.

The speed specified in this section may be adopted as a designated speed by the System.

Explanatory Note

The System is required to drive the vehicle in its lane on behalf of the driver when they are incapacitated to continue driving safely. We decided to set the maximum speed at 10 km/h in consideration of the following:

- Considerations for avoiding or mitigating damage from collisions with surrounding objects (including outside road users)

- Considerations for allowing outside road users to take such actions as avoiding collision with the vehicle being controlled by the System

- Consideration for being able to immediately stop the vehicle before entering a no-stopping zone, to ensure safety in the face of unforeseen circumstances, etc.

However, this maximum speed limit of 10 km/h does not apply if, with future technological progress, measures are taken to fully address the above considerations.

Further, while we require the designers to adjust the vehicle speed to an appropriate value not exceeding 10km/h, we accept that the speed temporarily exceeds the designated value in certain road conditions such as downhill, wet road surface, etc.

(2) Deceleration

The deceleration of braking by the System while running in the lane must be 2.45m/s^2 or less (4.00m/s^2 or less for vehicles exclusively for passenger use with a seating

capacity of less than 10 occupants). In the case of vehicles with standing capacity, such as route buses, the deceleration must be determined considering the risk of standing passengers falling over.

Explanatory Note

Based on the basic idea on driving assistance in ASVs, i.e., ensure maximum effects of accident avoidance and damage control to the extent that *safety is not compromised*, the designers must prescribe the degree of deceleration to be observed while driving the vehicle in its lane. The maximum deceleration level considering the risk of rear-end collisions is 2.45m/s^2 (4.00m/s^2 for passenger cars), a value accepted in the technical guidelines for adaptive cruise control systems (ACC) used with brakes. In consideration of passengers in vehicles with standing capacity, such as route buses, the deceleration must be determined considering the risk of standing passengers falling over.

We assume that those values will be socially accepted to the extent that we take technical measures to reduce the risk of secondary accidents, such as the control methods specified in this section and the alert to outside road users as specified in section 2.4.3.

2.3.2.2 Shift from the Function to Drive the Vehicle in Its Lane

When it becomes difficult to continue driving in the lane, the system shifts to the Function to Slow Down and Stop the Vehicle.

However, when the vehicle running at 10 km/h or less and having the Function to Avoid Stopping the Vehicle in No-Stopping Zones finds a no-stopping zone in the direction of travel, it shifts to the Function to Avoid Stopping the Vehicle in No-Stopping Zones only if the functions described in section 2.3.6.1 is maintained and considerations for safety have been given.

Explanatory Note

Cases where it becomes difficult to continue driving in the lane include cases where the vehicle's equipment has reached their performance limits, such as the camera checking the road ahead no longer recognizes the lane markings or the lane keeping assist system no longer working at bends.

2.3.3 Function to Have the Vehicle Change Lanes

This function allows the system, when it is driving the vehicle on behalf of the driver in a lane not adjacent to the roadside, to move the vehicle to the leftmost lane adjacent to the roadside.

Explanatory Note

This is a function, when the system is driving the vehicle in a lane that is not adjacent to the roadside on a multi-lane road, to have the vehicle change lanes to the leftmost lane from which to pull over to the roadside. Note that, until the vehicle starts changing lanes, the system uses the Function to Drive the Vehicle in Its Lane described in section 2.3.2.

2.3.3.1 How to have the vehicle change lanes

The vehicle's speed during lateral movements while changing lanes must not exceed 0.25 m/s (0.4 m/s for vehicles exclusively for passenger use with a seating capacity of less than 10 occupants). This rule does not apply, however, if sufficient consideration can be given to allow outside road users to take appropriate actions such as avoid collision with the vehicle being controlled by the System.

There must be no lane changes to right-hand lanes.

Explanatory Note

The lateral speed prescribed here is defined lower than that in normal lane change so that outside road users, such as other vehicles traveling in the lane toward which the vehicle is changing lanes, vehicles running diagonally behind the vehicle to left, and pedestrians, can recognize the vehicle changing lanes being controlled by the system and avoid collision with it. The period of time required for a normal lane change has been determined based on a study conducted by an informal group on Automatically Commanded Steering Function ("ACSF") that is discussing the revision of the international regulation on automatic steering (UN R79) (0.4 m/s for passenger cars as obtained by dividing an assumed vehicle width of 2 meters by 5 seconds needed from the time the left front tire starts crossing the lane marking to the time all the tires finish crossing it and 0.25 m/s for large vehicles, as obtained in the same manner by dividing an assumed vehicle width of 2.5 meters by 10 seconds needed from the time the left front tire starts crossing the lane marking to the time all the tires finish crossing it.)

2.3.3.2 Considerations to be given when changing lanes

To avoid collisions with other road users including vehicles and pedestrians travelling diagonally ahead of or behind the vehicle or lateral to the vehicle, etc. to left while changing lanes, considerations must be given:

(i) For the vehicle not to start changing lanes when it is likely to collide with other vehicles or pedestrians traveling diagonally ahead to left. Regarding the behavior of other vehicles travelling diagonally ahead of the vehicle to left, at least of two points must be made sure: they are either at a stop (0km/h) or may slow down sharply at a deceleration of $6m/s^2$. Regarding the behavior of pedestrians traveling diagonally ahead to left, it must be made sure at least that they are standing still. Here the "other vehicles and pedestrians traveling diagonally ahead to left" refer to those travelling diagonally ahead in the lane toward which the vehicle is about to change lanes.

Explanatory Note

Regarding the behavior of other vehicles travelling diagonally ahead of the vehicle to left, we defined their speed assuming that they are at a stop in a traffic jam and their deceleration expecting that they may activate an automatic electronic braking system (AEBS) to avoid a collision.

Since the vehicle should have sufficiently notified other road users of what is happening and is traveling at a low speed of 10 km/h or so and we can expect those road users to take appropriate action or activate AEBS, etc. to avoid collision with the vehicle, we don't require the designers to consider vehicles or pedestrians that may be coming toward the vehicle.

(ii) For the vehicle not to start changing lanes, when it is likely to collide with other vehicles or pedestrians travelling in lanes lateral to left. The "other vehicles and pedestrians traveling in lanes lateral to left" refer to those travelling lateral to the vehicle to left in the lane toward which the vehicle is about to change lanes.

(iii) For the vehicle not to start changing lanes, when it is likely to collide with other vehicles or pedestrians traveling diagonally behind to left. Regarding the behavior of those vehicles, at least all of the conditions below must be considered.

The "other vehicles or pedestrians traveling diagonally behind the vehicle" refer to those travelling in the lane toward which the vehicle is about to change lanes. Provided,

however, that, even when the vehicles or pedestrians traveling diagonally behind the vehicle detected by the System do not fit the assumptions made above, the System must take appropriate measures such as not start a lane change or interrupt a started lane change if a collision seems likely:

- The actual speeds of other vehicles and pedestrians travelling diagonally behind the vehicle at the time the vehicle's turn signals start flashing (but this does not apply if the vehicle can't detect such actual speeds because those road users significantly exceed: (i) the maximum speed indicated in traffic signs and markings if they are motor vehicles and motorcycles; (ii) 30 km/h if they are bicycles and mopeds; and (iii) 10 km/h if they are pedestrians.)

- At least 1.4 seconds must be allowed for the drivers of other vehicles travelling diagonally behind the vehicle to notice the vehicle changing lanes (moving sideways while flashing the turn signals) under the control of the System and to start slowing down. During this 1.4 second period, the vehicle continues running at the constant speed prescribed above.

- After the driver of a vehicle travelling diagonally behind noticed the vehicle changing lanes under the control of the System, they are assumed to start slowing down at a deceleration of 3 m/s^2.

Explanatory Note

The above behavior of a vehicle and a pedestrian travelling diagonally behind are presented as a rough guide to the minimum detection performance requirements that the System must satisfy on the assumption that those vehicles running at a legal speed will notice the Alert to Outside road users (section 2.4.3) and start slowing down, but actually we assume about the same range of detection as the field of vision that the driver of such a vehicle can check for safety through the rear-view mirrors, etc. The phrase "significantly exceeds" refers to a detection capacity that exceeds, with a good margin of safety, the minimum detection performance requirements indicated as a reference based on the actual traffic environment.

The study was made on the assumption that the drivers of other vehicles travelling diagonally behind the vehicle do not fail to notice the "Alert to Outside road users, etc." (Section 2.4.3) and slow down their vehicle.

In calculating the time it takes for the drivers of other vehicles travelling diagonally behind the vehicle to notice the vehicle changing lanes (moving sideways while flashing

the turn signal) under the control of the System and to start slowing down, we referred to three figures, namely:

(i) A minimum of 3 seconds for the flashing time of the turn signal of the vehicle changing lanes (set at 3 seconds before the vehicle starts a lateral movement in its lane by reference to the Road Traffic Act Enforcement Order)

(ii) A minimum of 1 second from the time it takes for the vehicle changing lanes to begin lateral movement in the same lane and to the time the left front tire begins to cross the lane marking while flashing its turn signal (set by reference to the discussion by ACSF informal group).

(iii) 0.4 seconds from the time the left front tire of the vehicle changing lanes begins to cross the lane marking to the time the driver of other vehicles travelling diagonally behind the vehicle starts slowing down (by reference to the discussion by ACSF informal group).

of which we added the figures (ii) and (iii) in calculating the time in question.

The deceleration was calculated in reference to the provisions for Category C being developed at ACSF (automatic lane change starting from the time the rider of a motorcycle, assumed as a vehicle travelling diagonally behind the vehicle, switched the turn signal on). For bicycles, we assumed that they can give a deceleration 30 m/s^2, the same value as motorcycles, considering that JSD9201: Bicycles – Braking Test Method requires 4.0 m/s^2 or more for the deceleration upon simultaneous braking on the front and rear wheels in dry weather

Shown below is an example of calculation of the detection distance required for the System to notice a vehicle running diagonally behind and decide whether it can still change lanes in the same way as ACSF people did. It should be noted that before the 0.4 seconds it takes for the driver of the vehicle travelling behind reacts to the vehicle crossing the lane marking, there is 1 second it takes for the vehicle from the time it started moving sideways and to the time just before its left front tire starts crossing the lane marking. Calculation is made the moment the vehicle crossed the lane marking, at which the collision risk actualizes.

For motor vehicles, we assume that the vehicle under control of the System is running at 10 km/h through the Function to Have the Vehicle Drive in Its Lane (Section 2.3.2), while the other vehicle travelling diagonally behind the vehicle is running at 60 km/h. A).

A) The relative speed of the two vehicles is 50 km/h. Assuming that it takes 0.4 seconds for the vehicle running diagonally behind approaches the vehicle controlled by the System keeping the relative speed and for the left front tire of the vehicle being controlled by the System starts crossing the lane marking and the time the driver of the another vehicle running diagonally behind starts decelerating the vehicle, we see that the two vehicles approach each other by 5.6 meters.

B) While the other vehicle running diagonally behind slows down from 60km/h to 10km/h at 3m/s^2, the two vehicles approach each other by 32.1 meters

C) Assuming that the time between the two vehicles at the point where the other vehicle running diagonally behind completes deceleration is 1 second, that corresponds to a distance of 2.8 meters. The zero-second time between the two vehicles is equivalent to a collision between the two vehicles.

The sum of A), B), and C) above, 40.5m (= 5.6m + 32.1m + 2.8m), is considered to be the shortest distance necessary for the System to notice the other vehicle running diagonally behind and determine whether or not to change lanes, when assuming that the time between vehicles in C) above is 1 second.

If the vehicle's performance is insufficient for the required detection distance, depending on the maximum speed of the road specified by traffic signs and markings, the system may be designed not to change lanes on such a road or to change lanes only when the system detects it. Such functional limitations must be clearly stated to drivers and others in advance.

For your information, the ACSF informal group defines for Category C that the detection distance for the vehicle running diagonally behind is 55m or more. This has been adopted as the distance at which motor vehicles, including motorcycles, running diagonally behind can be detected with current technology.

For bicycles, assuming that a bicycle diagonally behind is travelling at 30 km/h, the minimum distance necessary to decide whether or not to change lanes is 10.1 meters.

For pedestrians, we did not define neither the time they take to start slowing downs nor deceleration, considering their low maximum speed (about 10 km/h) and the risk of collision found low. Their walking speed was set at a similar value to that in the Basic Design Guide to pedestrian accident prevention system using communications being studied in the ASV Promotion Plan, 5th Phase.

(iv) Not to initiate a lane change in sections marked with prohibitive lane markings and within intersections and railroad crossings. This does not apply, however, when a lane change is necessary to avoid approaching emergency vehicles, damage to the road, a road construction site or other obstructions.

(v) Not to initiate a lane change when the vehicle is expected to, in doing so, enter a temporary lane restriction area, such as road construction sites.

(vi) Not to initiate a lane change when the vehicle seems unable to keep a distance of 1 meter or more from pedestrians.

Explanatory Note

In view of the Road Traffic Act, it is found appropriate to keep a distance of at least one meter from pedestrians while driving slowly.

2.3.3.3 Shift from the Function to Have the Vehicle Change Lanes

In the event that any of the situations considered in section 2.3.3.2 occurs after the vehicle started a lane change, the system must shift to the Function to Have the Vehicle Slow Down to a Stop.

However, when the vehicle having the Function to Avoid Stopping the Vehicle in No-Stopping Zones finds a no-stopping zone in the direction of travel, it shifts to the Function to Avoid Stopping the Vehicle in No-Stopping Zones only if the functions described in section 2.3.6.1 is maintained and considerations for safety have been given.

2.3.4 Function to Pull the Vehicle Over to the Roadside

This function allows the System to, on behalf of the driver, pull the vehicle from the lane adjacent to the roadside to the roadside or shoulder.

Explanatory Note

This is a function by which the System pulls the vehicle from the lane adjacent to the roadside to the roadside or shoulder. As to the function to follow until the System starts to do so, it stays in the Function to Have the Vehicle Drive in Its Lane described in section 2.3.2.

2.3.4.1 How to pull the vehicle over to the roadside

(1) Speed

The vehicle must keep the lane adjacent to the roadside at a speed not exceeding 10 km/h.

(2) How to pull the vehicle over to the roadside

The vehicle must be pulled over to the roadside or shoulder in such a manner to leave a certain space between the vehicle and the side wall or other road structure, so that the occupants can evacuate, etc., without difficulty after the stop.

Explanatory Note

When stopping the vehicle, make sure to leave a certain space from a side wall, etc. for easy evacuation, because if it stops too close, it may make it difficult for occupants to get out or for rescuers such as police, firefighters, etc. to enter the vehicle.

Specific values for such as space are not given here, because the road structure such as the width of the shoulder, or even whether there is such a shoulder, etc. in the first place, changes depending on where the vehicle is parked.

To shorten the distance needed till it stops, the vehicle may slow down as it pulls to the roadside.

2.3.4.2 Considerations to be given when pulling the vehicle over to the roadside

In order to avoid collisions with other vehicles and pedestrians present diagonally ahead of, behind, and lateral to the vehicle in the process of pulling over to the roadside, to prevent secondary accidents due to the vehicle's stoppage, and to avoid the vehicle's falling or overturning due to deviation from the road, the following considerations should be given:

(i) Not to start the function to pull the vehicle over to the roadside when a collision with another vehicle stopped at the roadside or shoulder, or with a cyclist or pedestrian travelling the roadside (including oncoming one) is expected. Regarding behavior of cyclists and pedestrians, give at least all the considerations prescribed below. Provided, however, that, even if cyclists or pedestrians detected by the System do not fit the

assumptions made, the System must take appropriate measures such as not start pulling over to the roadside or interrupt a started pulling-over if a collision seems likely:

- The actual speeds of cyclists and pedestrians (including oncoming traffic) in progress (except when the speed of a cyclist or pedestrian exceeds 30 km/h or 10 km/h, respectively, which would make detection impossible).

- At least 1.4 seconds must be allowed for the cyclists in progress to notice the vehicle changing direction (moving sideways while flashing the turn signals) under control of the System and to start slowing down. During this 1.4 second period, the vehicle keeps moving at the constant speed prescribed above.

- After the cyclist notices the vehicle's change of direction under control of the System, they are assumed to slow down at a deceleration of 3 m/s2.

Explanatory Note

The above behavior of bicycles and pedestrians is presented as a rough guide to the minimum detection performance requirements that the System must satisfy on the assumption that they will notice Alert to Outside road users (section 2.4.3) and start slowing down, but actually we assume about the same range of detection as the field of vision that the driver of such a vehicle can check for safety through the rear-view mirrors, etc. The phrase "significantly exceeds" refers to a detection capacity that exceeds, with a good margin of safety, the minimum detection performance requirements shown as a guideline, based on the actual traffic environment. In addition, depending on the detection performance of the vehicle, Systems that pull the vehicle over to the roadside only when it detects them (i.e., does not pull the vehicle over to the roadside even if there is no cyclist or pedestrian in progress in the left lane including oncoming cyclists and pedestrians) are accepted, too.

Adequate warning to outside road users is expected to encourage them to take action avoiding collision, etc., but, on the roadside of a local road, unlike on a expressway or in a lane of a local road, there may be oncoming or approaching vehicles and pedestrians. In order to protect pedestrians, etc. based on the basic idea on driving assistance of ASVs, i.e., ensure maximum effects of accident avoidance and damage control to the extent that safety is not compromised, we decided to give consideration also to oncoming or approaching vehicles and pedestrians.

(ii) Not to start pulling over to the roadside when the vehicle risks falling from the road or rolling over.

(iii) If the system has the Function to Avoid Stopping in No Stopping Zones, not to activate the function to pull over to the roadside if it is likely to stop in a no-stopping zone.

2.3.4.3 Shift from the Function to Pull the Vehicle Over to the Roadside

If an event that meets the assumptions made in section 2.3.4.2 occurs after the System started pulling over to the roadside, the System shifts to the Function to Have the Vehicle Slow Down to a Stop.

However, when the vehicle having the Function to Avoid Stopping the Vehicle in No-Stopping Zones finds a no-stopping zone in the direction of travel, it shifts to the Function to Avoid Stopping the Vehicle in No-Stopping Zones only if the functions described in section 2.3.6.1 is maintained and considerations for safety have been given.

Explanatory Note

If the vehicle interrupts a direction change after starting it and pulls over to the roadside after crossing the section considered above, that may give difficulty to surrounding road users, e.g. in anticipating the vehicle's movement and taking proper action. The System hence must shift to the Function to Slow Down and Stop the Vehicle or the Function to Avoid Stopping in a Non-Stopping Zone.

2.3.5 Function to Slow Down and Stop the Vehicle

This function allows the System to slow down and stop the vehicle on behalf of the driver.

2.3.5.1 How to brake the vehicle

The deceleration of braking by the System must not exceed 2.45m/s^2 (4.00m/s^2 for vehicles exclusively for passenger use with a seating capacity of less than 10 occupants). In the case of vehicles with standing capacity (designed assuming standing passengers), such as route buses, the deceleration must be determined considering the risk of standing passengers falling over.

Explanatory Note

The same applies as section 2.3.2.1 (2).

The effectiveness of the gradual braking method has not been recognized yet in view of a study by the National Traffic Safety and Environment Laboratory (at that time) using a driving simulator, which showed that such a method risked shortening the distance between the braking vehicle and the following one.

2.3.5.2 Keeping the vehicle at a stop

The vehicle must remain at a stop until the System is deactivated.

Explanatory Note

If the vehicle stops due to traffic congestion or other reasons after the System took control, the vehicle must remain at a stop until the System is deactivated.

2.3.5.3 Assistance to steering

To avoid a stop straddling two lanes or to keep the direction of travel, the System may steer the vehicle on behalf of the driver until it stops.

Explanatory Note

Since the System may need to shift to the Function to Have the Vehicle Slow Down to a Stop by interrupting the change of direction, it is allowed to steer the vehicle to avoid a stop straddling two lanes or to keep the direction of travel.

2.3.6 Function to Avoid Stopping the Vehicle in No-Stopping Zones

This function allows the System to, on behalf of the driver, prevent the vehicle from entering or stopping in a no-stopping zone.

2.3.6.1 How to avoid stopping the vehicle in no-stopping zones

If it is judged that the braking distance before stopping by the braking method described in section 2.3.5.1 exceeds the distance between the no-stopping zone and the front end of the vehicle or if the vehicle has already entered the no-stopping zone, the System may temporarily interrupt slowing down on the condition that safety consideration has

been given to avoid stopping in the no-stopping zone. In this case, however, the speed while interrupting deceleration must be 10km/h or less; the System must keep alerting people to the braking; and the vehicle must be slowed down to a stop as soon as it avoided stopping in the no-stopping zone. The provisions in 2.3.5.1, 2.3.5.2, 2.3.5.3 must apply for the braking method, keeping the vehicle at a stop, and assistance to steering, respectively.

When stopping the vehicle just before the no-stopping zone to prevent it from entering it, the System may brake the vehicle at a deceleration greater than that specified in the braking methods prescribed in section 2.3.5.1. Provided, however, that the vehicle speed must be 10 km/h or less and that the System must keep alerting other road users to the braking.

The speeds specified in this section may be adopted as value designated by the System.

Explanatory Note

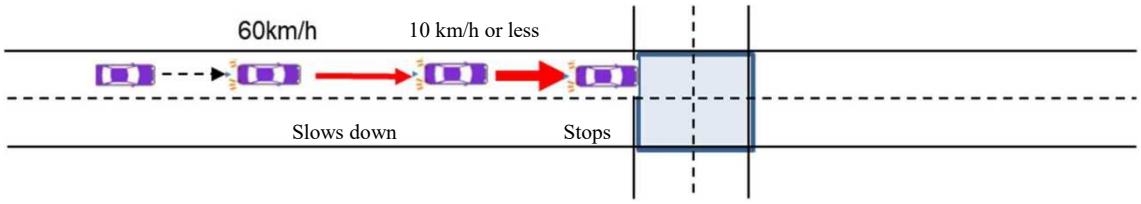
The no-stopping zones that we have currently in mind are intersections, railroad crossings, etc. likely to expose the vehicle to serious secondary accidents. Other no-stopping zones, such as locations where parking and stop are prohibited, must be dealt with according to how technology advances and it is desirable that this function too will be made mandatory in the future. The stopping boundary for an intersection or railroad crossing is defined here as being immediately before the stop line if the intersection has a stop line, or immediately before the intersecting road if the intersection doesn't have one, or immediately before the stop line if the railroad crossing has one, or immediately before the railroad crossing if it doesn't have one.

Examples of safety considerations to be given when passing through the no-stopping zone are the activation of a function that recognizes intersections and railroad crossings, continued alerting, slowing down to 10 km/h or less, and providing the vehicle with an automatic emergency braking system (AEBS). For vehicles with standing capacity such as route buses, however, other ways to avoid collisions with other vehicles and pedestrians may be also envisaged.

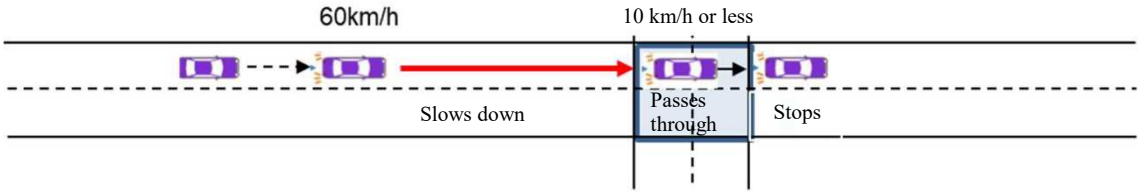
Shown below illustrates how this function works taking as an example a case where the driver incapacity occurs before a no-stopping zone while the vehicle is driving at 60km/h (Fig. 3). If the System does not have this function (a system that has only a function to slow down and stop the vehicle), the vehicle either enters, or stops before, the no-stopping zone depending on the situation. On the other hand, if the System has

this function and the vehicle can slow down to 10 km/h or less before reaching the no-stopping zone, the System can stop the vehicle just before the no-stopping zone by applying braking at or above the deceleration specified in Section 2.3.5.1 (Fig. 3 (i)). On the other hand, if the vehicle cannot slow down to 10 km/h or less before entering the no-stopping zone but only after entering it, the deceleration can be temporarily interrupted at that point, so that the vehicle is brought to a stop after passing the no-stopping zone (Fig. 3 (ii)).

(i) Stops before the no-stopping zone
(When the vehicle was able to slow down from 60 to 10km/h or less before entering the no-stopping zone)



(ii) Stop only after passing through the no-stopping zone
(When the vehicle cannot slow down from 60 to 10km/h or less before entering the no-stopping zone)



No slowing down

Slows down at a deceleration specified in section 2.3.5.1

Slows down at a greater deceleration than one specified in section 2.3.5.1

Figure 3: How the System works with this function

2.3.6.2 Shift from the Function to Avoid Stopping the Vehicle in No-Stopping Zones

If the System judges that it is not appropriate to perform or continue the Function to Avoid Stopping the Vehicle in No-Stopping Zone, it shifts to the Function to Slow Down and Stop the Vehicle.

Explanatory Note

"Inappropriate" cases may include cases where it became difficult to give safety considerations due to a sudden change in the traffic environment or the occurrence of unforeseen circumstances, or where the System has reached its functional limits or has failed.

2.3.7 Overriding the System's control

(i) Accelerator operation:

While the System is controlling the vehicle, the driver's accelerator maneuver is disabled.

Explanatory Note

According to the analysis of accidents caused by driver incapacity, some accidents are thought to have been caused by the driver losing their posture and stepping on the accelerator pedal (see the report by the Traffic Accident Analysis Center, "Study of Traffic Accidents Caused by Seizures and Sudden Illnesses of Four-Wheeled Drivers"). The accelerator operation while under the control hence is disabled.

(ii) Braking maneuver:

If the braking force generated by the driver's braking maneuver exceeds the braking force of the System, then the driver's braking maneuver overrides the System's.

Explanatory Note

There may be cases where, even feeling fainting, the driver tries to stop the vehicle to avoid colliding with obstacles. With regard to braking, therefore, we find it appropriate to allow the driver to override the System's control.

(iii) Steering maneuver:

The driver may be allowed to override the System's control only when their steering maneuver has been judged intentional.

Explanatory Note

A steering maneuver overriding the System's control is valid when it is an intentional avoidance maneuver by the driver feeling fainting and yet trying to control the vehicle or a passenger trying to do so for the driver, but isn't when done by the driver collapsing and accidentally turning the wheel, taking the vehicle off the road.

The ways to know whether a steering maneuver is intentional or not include monitoring the driver's posture for collapse through a camera, checking a steering maneuver against known obstacles ahead, etc.

On the other hand, as the steer-by-wire system technology (which controls the vehicle's steering through electric signals representing steering angles) develops in the future, it will be possible to disable the driver's steering maneuver and give the System steering priority as far as it accurately detects driver incapacity and the steer-by-wire system works properly.

2.3.8 Constraints on distance and time from when the System takes control to when it stops the vehicle

The upper limit of the distance the System travels from when it takes control to when it stops the vehicle is 150 meters. The upper limit of the time the System takes from when it takes control to when it stops the vehicle is 60 seconds.

Explanation

The purpose of the System is to address the driver's sudden incapacity to continue driving, which makes it desirable that the vehicle be parked somewhere before rescuers (police, firefighters…) arrive and start working. A time limit is hence set on the time the System takes from when it takes control to when it pulls the vehicle over to the shoulder or roadside and stops it. Further, for the Systems not provided with the Function to Avoid Stopping in No Stopping Zones, too, a limit distance of 150 meters is set, which is the minimum distance to be placed between two traffic lights or intersections on local roads prescribed by the National Police Agency, in order to eliminate or minimize the

number of times a wrecked vehicle needs to enter an intersection before finding an evacuation space on the roadside, etc.

From the above, we estimated the time the System would take from when it takes control to when it pulls the vehicle over to the roadside or shoulder and stops it while driving the vehicle over the 150 meter distance at a constant speed of 10km/h, letting the engine slow down.

(i) The time the vehicle takes to slow down from 10km/h at 0.5m/s^2 (the approximate deceleration while the vehicle slows down by engine braking, etc.) is 6 seconds and the driving distance is 9 meters.

(ii) The distance the vehicle travels at a constant speed of 10km/h is 141 meters (150 meters – 9 meters) and the time it takes to travel it is 51 seconds.

The total of (i) and (ii) above is 57 seconds, or 60 seconds when rounded.

2.3.9 Conditions for shift to the Function to Slow Down and Stop the Vehicle

The System must shift to the Function to Slow Down and Stop the Vehicle when it identifies any of the following events:

(i) A control system has been activated to avoid or mitigate a collision.

Explanatory Note

The activation of the control system to avoid or mitigate a collision suggests the occurrence of an event immediately before the activation, such as a vehicle cutting into the lane ahead of the vehicle. In such a situation, it is preferable not to continue driving.

(ii) The System finds it likely to exceed either of the time or distance limits from when it takes control to when it stops the vehicle; or

(iii) The System finds a steering maneuver done. Provided, however, that this does not necessarily apply if it is judged that the maneuver is intentional.

(iv) The system judges that it is inappropriate to perform or continue the Function to Have the Vehicle Drive in Its Lane, the Function to Have the Vehicle Change Lanes,

Function to Pull the Vehicle Over to the Roadside, or the Function to Avoid Stopping in No Stopping Zones.

Explanatory Note

"Inappropriate" cases may include those where it becomes difficult to give safety considerations due to a sudden change in the traffic environment or the occurrence of unforeseen circumstances, as well as functional limitations or failures of the System.

2.3.10 Shift to the Function to Avoid Stopping the Vehicle in No-Stopping Zones

If the vehicle has a Function to Avoid Stopping in No-Stopping Zones, the system must shift to the Function to Avoid Stopping in No Stopping Zones when the vehicle is likely to enter a no-stopping zone while the Function to Drive the Vehicle in Its Lane, the Function to Have the Vehicle Change Lanes, or the Function to Pull the Vehicle to the Roadside is in operation.

2.3.11 Other considerations to be given in relation to the Function to Evacuate the Vehicle to the Shoulder, etc.

(i) Considering that, even satisfying the requirements in section 2.3, the vehicle may have unpredictable collisions while under control of the System and that the vehicle may have a collision entering, or stopping at, a red-light intersection or railroad crossing while a train is passing, consideration should be given to avoid these collisions or mitigate the damage.

(ii) It is desirable that the System be used in combination with emergency response and other reporting systems/services to enable the System to avoid secondary damage due to collisions with outside road users, to rescue passengers for their safety, and to save the life of a driver who became incapacitated to continue driving safely due to a sudden change in their physical condition, all at an early stage.

Explanatory Note

It is desirable that the System be used in combination with an Automatic Emergency Braking System (AEBS), etc. considering that the vehicle may collide with structures, installations, people, or other vehicles that are difficult for the System to detect in advance. It is also desirable that the System be used in combination with a system that

prevents it from entering a red light intersection or railroad collision while a train is passing, etc. because doing so may expose it to the risk of serious secondary accidents.

The System is designed, when the driver suddenly became incapacitated to continue driving after a sudden change in their physical condition, to avoid secondary damage caused by collisions with outside road users, etc. and to ensure the safety of occupants as an emergency measure. It is expected that, if the System is used not only alone but in coordination with other information and communication systems and road infrastructures, the System will provide even greater safety.

2.4 Function to Notify People of What the System Is Doing

2.4.1 Alert to the driver

2.4.1.1 “System Activated” Alert

The System starts notifying the driver when their incapacity is detected and ends when the System is deactivated or when the Control Activated Alert is given.

The ways the alert is given include a visual alert as mandatory one. Notification by at least one of the auditory, tactile, or physical sensations from slow deceleration is also mandatory.

Whether or not to give a notification of the start of the System’s operation after the driver has pressed the activation switch is optional.

Explanatory Note

If the driver is normal, they disable the System to take control of the vehicle in response to the alert that the operation started by deactivating the system (see section 2.3.1, "Timing to start controlling the vehicle ").

The way to give alerts may be changed during the process. For example, the auditory alert may be switched to an alert to passengers at the same time as the start of alert to passengers (section 2.4.2.2).

Thereafter, the ways tactile alerts are made must include, for example, one that communicates through the vibration of the steering wheel. Further, alerts through physical sensations from slow deceleration is also acceptable.

2.4.1.2 “Control Activated” Alert

The alert must begin when the System has taken control of the Vehicle and end when it has been deactivated.

As the ways to give the alert, in addition to visual alert, either auditory or tactile alert is mandatory.

Explanatory Note

The ways alerts are made after the vehicle stops may be changed from the ones used before the stop.

2.4.2 Alert to passengers

2.4.2.1 “System Activated” Alert

In the case of the Passenger-activated type, the System may notify the passenger who has pressed the button that the System is about to be activated.

The alert must start when the passenger has pressed the activation switch and end when the System has been deactivated, or when a Warning Alert starts or when the Control Activated Alert has been made.

The way to give the alert is optional.

Explanatory Note

An example of the ways to notify the passenger that the System has been activated is to light up the activation switch’s indicator lamp.

The ways to notify the passenger who pressed the button that the System has been activated is may be the same as the ways to notify the driver that the System has been activated.

2.4.2.2 Warning Alert

If a warning alert is to be made, the alert must be started before the System takes control of the vehicle.

The alert ends when the System is deactivated or when it has taken control of the vehicle.

Whether or not to make a warning alert to the passengers is optional, but is mandatory for vehicles with standing capacity, which does not apply if the vehicle is at a stop. When making a warning alert, auditory means is mandatory and visual means optional, which is however desirable for vehicles with standing capacity.

Explanatory Note

This is a warning alert that the System is about to take control of the vehicle. For vehicles with standing capacity, a warning alert is mandatory to reduce the risk of standing passengers falling over. A proviso is added for when the vehicle is at a stop, in which case passenger would not need to brace for falling.

If the warning alert is done to the driver who has pressed the button, it may be started either after the driver has had time to deactivate the system (assuming it was an accidental activation) or immediately after the driver has pressed the button.

With regard to an alert to passengers by auditory means, consideration must be given to ensure that all passengers (in the vehicle) are notified, regardless of whether that is a Warning Alert or a Control Activated Alert (Section 2.4.2.3). On the other hand, for alerts by visual means, it is not necessary that they be visible to all passengers in the vehicle no matter where they are.

The way to make Warning Alerts to the passengers may be the same as the way the System Activated Alert is made to the driver.

2.4.2.3 “Control Activated” Alert

The alert starts when the system takes control of the vehicle and ends when the system is deactivated.

Auditory alert is mandatory and visual alert optional, which is however desirable for vehicles with standing capacity.

Alert may include warning to the passengers against what might happen as the vehicle slows down to a stop or changes the direction. In particular, when the vehicle is about to change lanes or change direction toward the shoulder, etc., a warning must be given before the start of such a change.

Explanatory Note

The way to notify the passenger of the System taking control of the vehicle may be the same as the way to notify the driver of the same event.

The ways alerts are made after the vehicle has been stopped may be changed from the ways they were before the stop.

In order to avoid unnecessary intervention of passengers in the operation of the System, or in consideration of the risk of passengers falling over for vehicles with standing capacity, warning alerts may include warnings to the passengers against the vehicle's next moves (e.g., changing direction, slowing down and a stop). In particular, when changing direction, notifying the passengers in advance of what the System is about to do can urge people to take actions to protect themselves (hold on to the bus's railing, sit down, check the seat belt, etc.). In such a case, audio announcements and in-vehicle display seem suitable as the means of alert.

2.4.3 Alert to outside road users

2.4.3.1 Warning Alert

If a warning alert is to be made, it must be started before the System takes control.

It ends when the System has been deactivated or when the Control Activated Alert has started.

When a warning alert is to be made, emergency flashing lights, auditory alerts such as alarm horns, or visual alerts such as text displays may be used.

Whether or not to make warning alerts to outside road users is optional.

Explanatory Note

Warning alerts are not mandatory because they are alerts between the time the driver incapacity has been suspected and the time when it has been confirmed. However, to prepare people for safety risks, we find it socially acceptable to notify outside road users in an early stage even if the incapacity has not been confirmed yet. Thus we include this warning alert as an option.

The purpose of making warning alert to outside road users is to notify them that an emergency situation is likely to happen and to urge them to stay away from the vehicle. Means of auditory alerts such as emergency flashing lights and horns are also allowed.

Regarding the effect of the period of time of warning alerts on the driving behavior of other vehicles behind the vehicle, there is a study conducted by the (then) National Traffic Safety and Environment Laboratory in 2014 using a driving simulator. The study showed that the risk of rear-end collisions with other vehicles does not decrease with a longer duration of warning alert. If the warning alert period of time was too long, there were cases where the following vehicle once slowed down but then re-accelerated.

2.4.3.2 “Control Activated” Alert

The Control Activated Alert starts when the system takes control and ends when the system is deactivated.

As the ways to make the alert, it is mandatory to include an emergency flashing light, horns or other audible alerts, and braking lights while braking. A visual alert such as a text display also may be used in combination.

The alert must be maintained for at least 3 seconds immediately after the System has taken control while performing the Function to Drive the Vehicle in Lane" (section 2.3.2); provided, however, that, when a warning alert to the same effect as the Control Activated Alert is given, the above 3 seconds may include the time of such a warning alert.

Explanatory Note

When slowing down, the vehicle must notify other vehicles of that with braking lights to prevent rear-end collisions. Also mandatory is the use of emergency flashing lights and an audible alert such as horns to notify other road users of the emergency situation and urge them to stay away from the vehicle under control of the System.

After the vehicle stopped, the ways to make alerts may be modified from the one used till then.

To alert other vehicles in the vicinity that the vehicle is under control of the System and to keep them away from the vehicle, it is mandatory to keep the emergency flashing lights on, an audible alert such as horns, and braking lights while braking for at least

three seconds immediately after the System has taken control, using a visual alarm such as a text display in combination optionally. The function the System performs in this stage is the Function to Drive the Vehicle in Lane, waiting the time it can shift to the Function to Have the Vehicle Change Lanes as early as possible.

If an warning alert is to the same effect as the Control Activated Alert is done, the above three seconds may include the time of such a warning alert, because that means we can notify other road users more quickly that the vehicle is under the System's control. While the Control Activated Alert is being made, the Vehicle is under the Function to Drive the Vehicle in Lane.

When the Vehicle changes direction to change lanes or pull over to the shoulder, it must stop flashing the emergency lamp and start flashing turn signal lamps from 3 seconds before it begins to move laterally in the same lane. The turn signal lamps must continue flashing till the change of direction is completed.

Explanatory Note

While the Function to Drive the Vehicle in Its Lane and the Function to Slow Down and Stop the Vehicle, the emergency lamp must be kept flashing

When shifting to the Function to Have the Vehicle Change Lanes, the vehicle stops its alert with the emergency flashing lamp and starts that with flashing the turn signal lamps.

When under the Function to Pull the Vehicle Over to the Roadside, the System alerts other road users with an emergency flashing lamp while slowing down in lane and by flashing turn signals while changing direction and pulling over to the roadside.

When changing lanes and changing direction to pull over to the shoulder, etc. as specified in this section, the alert with flashing turn signals must begin three seconds before the vehicle starts moving laterally in the same lane and continue till the change of direction is completed (see the Explanatory Note in section 2.3.3.2 (ii)).

Figures 4-1, 4-2, and 4-3 show a summary of how the alerts prescribed in sections 2.4.1 through 2.4.3 are performed over time. Fig. 4-1 is the alert timing chart for an automatic driver incapacity detection type, Fig. 4-2 is for a driver-activated type, and Fig. 4-3 is for a passenger-activated type.

2.4.4 Considerations to be given in relation to alerts

When making the System Activated Alert, a Warning Alert, and the Control Activated Alert, it is desirable that consideration is given to avoid interfering with voice communication, etc. for emergency response and other alert systems and services.

Explanatory Note

In vehicles equipped with a reporting system/service for emergency response, etc., consideration should be given to enabling the volume of auditory alerts to be adjusted appropriately so that the auditory alerts of the System do not interfere with the conversation between passengers and the operator of the reporting system/service for emergency response.

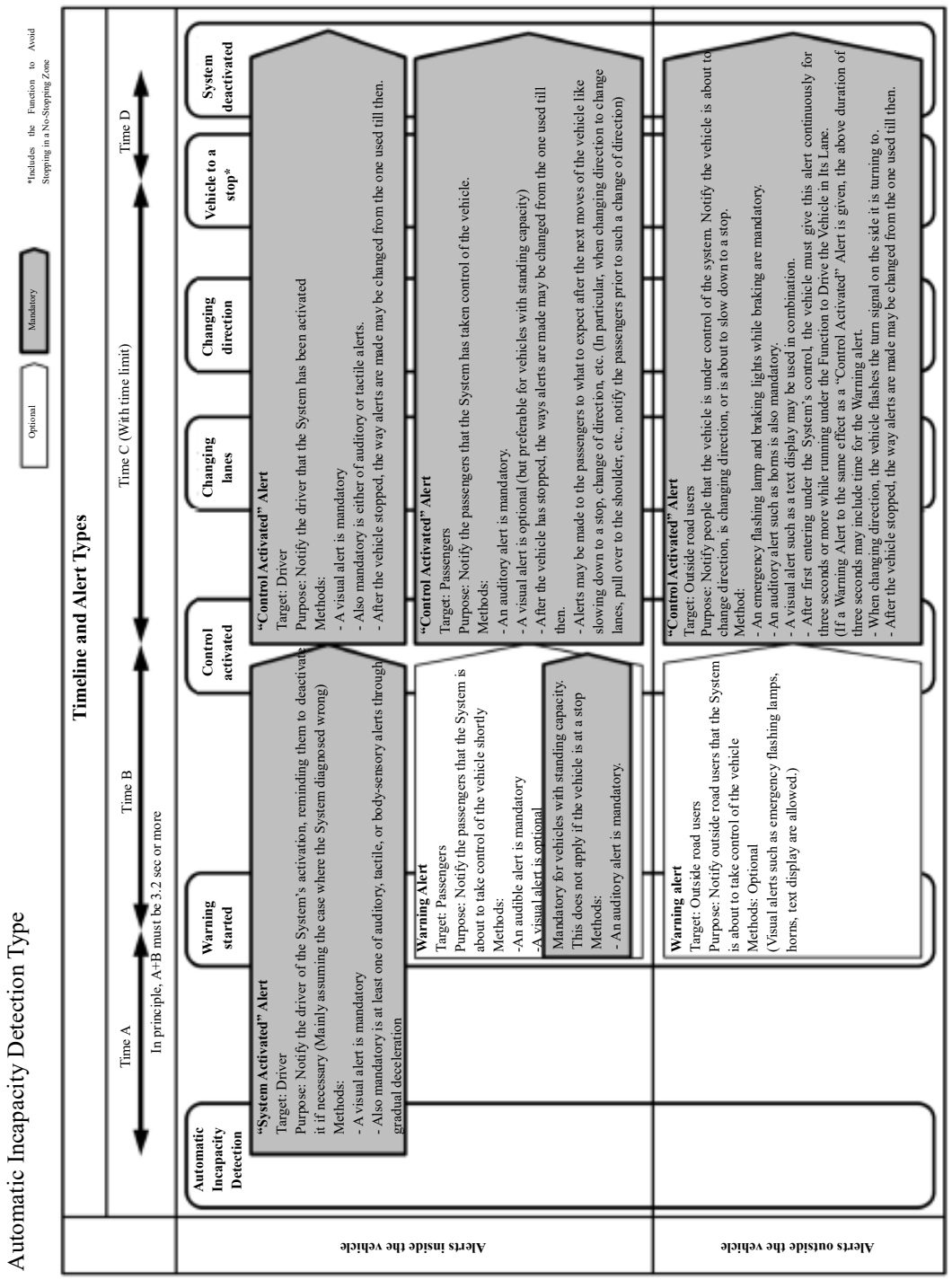


Fig. 4-1 Automatic Incapacity Detection Type

Alert Timing Chart

Driver-Activated Type

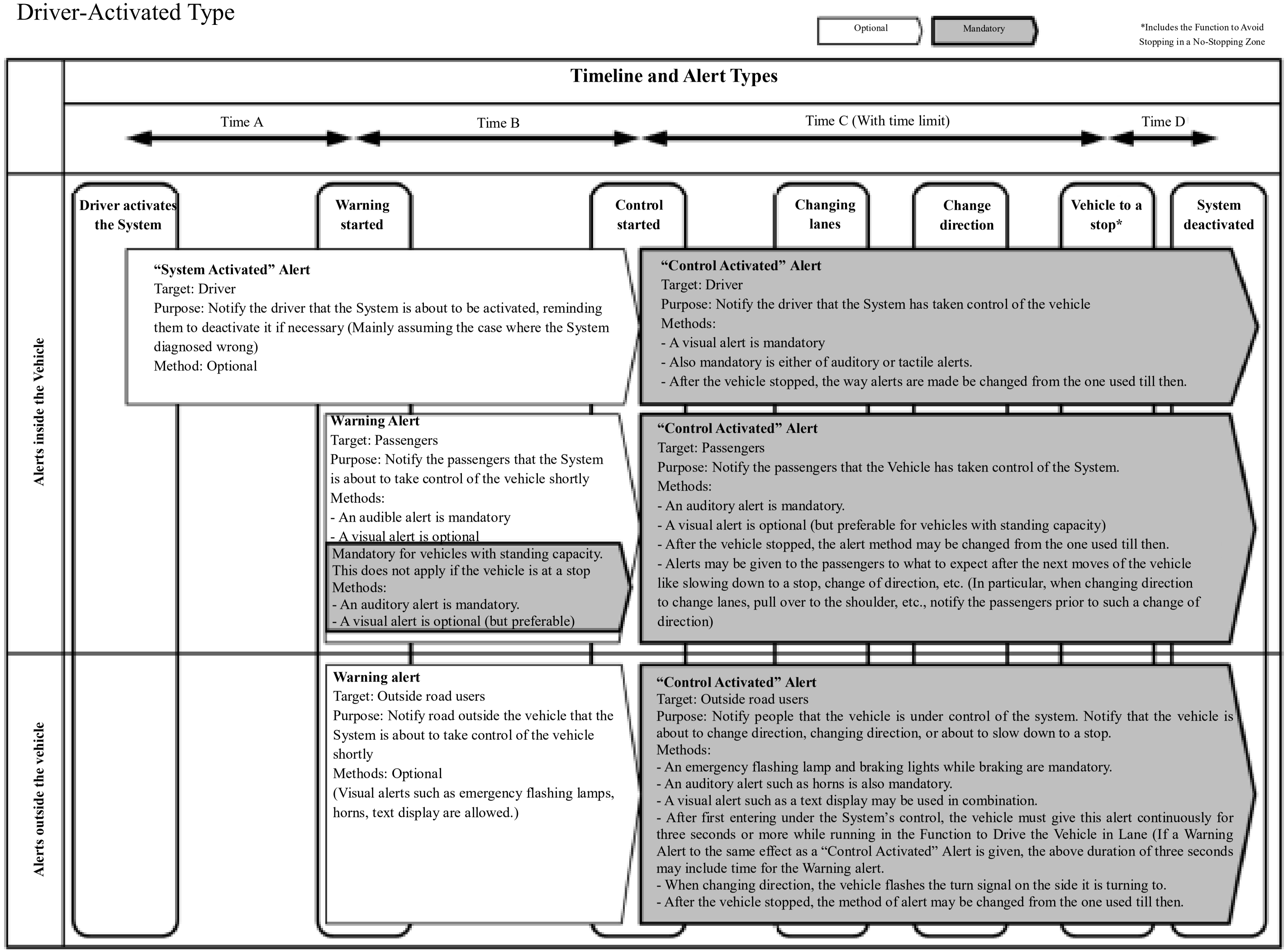


Fig. 4-2 Driver-Activated Type

Alert Timing Chart

Passenger-Activated Type

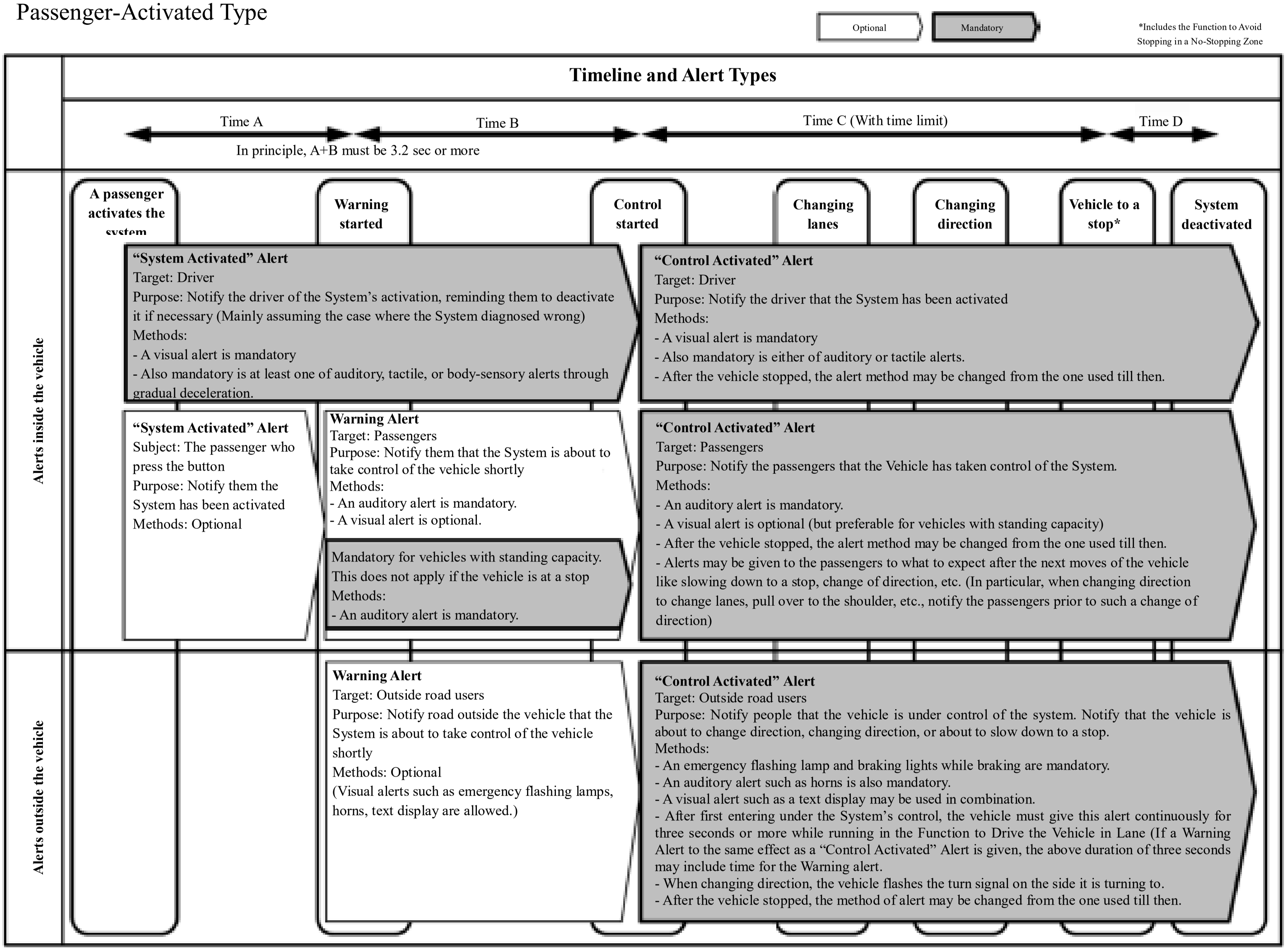


Fig. 4-3 Passenger-Activated Type

Alert Timing Chart

2.5 Deactivation

A deactivation switch must be installed that allows the System to be deactivated.

Explanatory Note

In installing the deactivation switch, considerations must be given to the points below assuming handling by the driver in a normal condition or a rescuer:

1) The switch must be easy to find and handle without bothering driving maneuvers

2) The switch must not be easy to handle for an incapacitated driver or passenger.

3) The switch must be easily recognizable as a deactivation button for rescuers, too.

The deactivation switch may be used also as the main switch.

Depending on the System's configuration, deactivating the System may cause the vehicle to start moving.

The System must not be deactivated till the deactivation switch is pressed or till it is confirmed that the driver is in a normal condition through certain maneuvers.

Explanatory Note

This does not apply when the System is no longer operative due to the damage of the vehicle from a collision, inability to control the vehicle stably, lack of fuel, low battery, ignition power off, etc.

The ways to make it easier for the vehicle to stay parked even after the System is automatically stopped include automatically applying the side brake or automatically putting the vehicle into parking.

When the Automatic Driver Incapacity Detection System has detected the driver's incapacity and activated the System, the driver may be judged to be in a normal condition allowing them to drive the vehicle normally if, after the system activation, their driving maneuvers are judged normal and intentional ones.

2.6 Designing a System that Uses Multiple Means of Driver Incapacity Detection in Combination

In designing a vehicle that uses multiple means of driver incapacity detection in combination (automatic type, driver-activated type, and passenger-activated type), we can assume cases where multiple detection means detect the driver incapacity at the same time. In such a case, the alert and control must be performed in accordance with the type that can shift to the control start stage fastest in terms of the timing to start controlling the vehicle as set in advance for each type.

Explanatory Note

For example, in the case of a vehicle equipped with all types of driver incapacity detection system (automatic type, driver-activated type, and passenger-activated type), we can assume a case where, when the driver incapacity occurs, the System automatically detects the incapacity, a passenger noticing it and the driver themselves also presses the button, all of the three means working at the same time. In such a case, in order to stop the vehicle as soon as possible, the alert and control operations must be performed in accordance with the type that can shift the fastest to the "Control Activated" stage.

2.7 Measures to be Taken upon a System Failure

(i) The System must be provided a means by which, if the System detects a failure, the driver sees that failure, too.

(ii) Consideration must be given to ensure that a possible System failure does not affect the vehicle's proper functioning.

(iii) In the event the System fails while activated to address driver incapacity, it is desirable that the vehicle be slowed down to a stop to the extent that such function still can be activated.

(iv) If the vehicle is provided with more than one driver incapacity detection means and a failure is found only in some of such detection means, the System must be kept in operation using the detection means not found faulty.

Explanatory Note

Considering technical difficulties, the System is not required to have a self-diagnosis feature to detect its own failures.

To avoid a situation in which the System is malfunctioning when the driver's condition changes suddenly and the System cannot fulfill its mission, it is necessary to install an indicator, etc. that clearly indicates the System failure to the driver, etc. to urge them to repair the System as soon as possible and to maintain the System on a regular basis.

In order, for the functions of the vehicle common to those of vehicles without the System, to function as it should (in braking, driving, and steering) even when the System fails, it is useful to increase the reliability of the function of the vehicle by duplicating the braking, driving, and steering systems so that the other systems will not be affected. However, we do not require such duplexing because such duplexing may complicate the configuration of not only the System but also the entire system of the vehicle.

A case of a vehicle provided with multiple means of driver incapacity detection may be the one that uses three types in combination: an automatic system, a driver-activated system, and a passenger-activated system. In such a case, even if the automatic system fails, the System still can be activated with the driver-activated system and the passenger-activated system.

2.8 Priority Approach to Conflicts with Other Driver Assistance Control Systems

In cases where a conflict arises in terms of alert and control functions between the System and other driver assistance control systems that are operating simultaneously, the following approach must be taken:

2.8.1 Control systems intended to keep the vehicle’s behavior stable

Automatic emergency braking systems, electronic stability control systems, and other systems used to keep the vehicle’s behavior stable must properly function regardless of whether the System is activated or deactivated.

Explanatory Note

The function to stabilize the vehicle's behavior is assumed to be active all the while the System is controlling the vehicle. The automatic emergency braking system, for instance, is expected to provide stable braking even when the control of the System operates on a slippery road surface such as a snow surface.

2.8.2 Control systems intended to avoid or mitigate collisions

For other systems that perform controls aimed at avoiding or mitigating collisions, the alert and control of other systems takes precedence. After the other system has completed its operation, the System takes precedence.

Explanatory Note

Facing a risk of impending collision, the system intended to avoid or mitigate collisions capable of assessing the urgency of the collision should be given priority over the System that is not capable of assessing such urgency. Systems intended to avoid or mitigate collisions are control systems that detect and respond to impending collisions. An example of such systems is an automatic emergency braking system. The System is intended to detect the driver's incapacity, but not to assess the urgency of a collision based on the driving environment and respond to it.

In the future, if systems to avoid entering a red-light intersection or a railroad crossing while a train is passing or expected to pass, or a system to avoid an imminent collision by steering are put to practical use, they should be activated in priority over the System from the same viewpoint of urgency,.

2.8.3 Control systems not intended to avoid or mitigate collisions

Once the System has been activated and "Control Activated" Alert has started, priority must be given to speed adjustment and steering control by the System.

Explanatory Note

The System is intended as an emergency response to a sudden change in the driver's physical condition. In terms of speed adjustment and steering after the "Control Activated" Alert started, the System is given priority over other driver assistance control systems such as cruise control (CC) and adaptive cruise control (ACC) systems, which are designed to lighten the workload of a normal driver, to stay on the safer side.

On the other hand, no special provisions are made for speed adjustment by the System before the "Control Activated" Alert starts, i.e., while the "System Activated" Alert or Warning Alert are being made. However, considering the risk of the driver incapacitated at the very moment, the System is allowed, if other driver assistance and control systems such as ACC are activated and applying brakes, to keep such braking active in

order to prevent the vehicle from approaching preceding vehicles too much and stay away safer.

Steering to stay in lane and not to leave the road by other driver assistance control systems should continue even while the “System Activated” Alert and Warning Alert are being made. In the future, various driver assistance control systems may be put to practical use and, for each of those systems, we will review the concept of priority with the System according to the purpose and detailed requirements of such systems and revise it as necessary.

3. Special Notes

Non-technical considerations to be given are as follows:

Explanatory Note

With regard to this special note, it is desirable that all parties involved in the prevention of accidents caused by driver incapacity make efforts in a comprehensive manner.

3.1 Raising Social Awareness (education activities, etc.)

Consideration must be given to ensure that all road users, including motorcycle riders, cyclists, and pedestrians, understand the following:

(i) What the driver incapacity response system is for.

(ii) How to identify vehicles in which the System is operating.

(iii) What to do when one see a vehicle under the System's control.

Explanatory Note

The ways to raise the public awareness of the System include education activities distributing flyers, etc., among children at school, and among the elderly.

In addition to riding in vehicles equipped with the System, it is desirable to publicize the System at places and in ways easily accessible to the public through advertisements, websites, and other PR activities.

3.2 Informing Drivers about the System

Through instruction manuals, displays, etc., drivers must be properly informed of the following:

(i) The purpose, type, and effect of the System.

(ii) The conditions under which the System can be activated and not.

(iii) The auditory alerts, messages, etc., given by the System and their meaning.

(iv) Functional limitations of the System.

(v) Responsibilities for the operation of the System.

(vi) Other precautions for use.

Explanatory Note

The above items are listed as information necessary for drivers to understand and use the System correctly. Leaving a written record certifying that the System has been fully explained to the driver or the operation manager is meaningful to certain extent as proof that the obligation to explain the System has been fulfilled.

The "type of system" varies according to the various combinations of functions, such as whether the means of detection of driver incapacity of the System is an "automatic type" or a "driver- or passenger-activated type", whether it is a type that activates the function to pull the vehicle over to the roadside only when the vehicle is in the leftmost lane, etc.

3.3 Informing Passengers

Considerations must be given to let the following be well known to passengers by means of signs, notices, etc.:

(i) The purpose, type and effect of the System.

(ii) How to use the System.

(iii) The auditory alerts, messages, etc., given by the System and their meaning.

(iv) Functional limitations of the System.

(v) Responsibilities related to the operation of the System.

(vi) Other precautions for use.

Explanatory Note

Signs, notices, etc. for education purposes must be posted in conspicuous locations in the vehicle. For example, a notice facing the passengers' seats or in advertising space in a route bus, displays in the cabin, etc. In the case of long-distance coaches, a video manual like the one used in airplanes before taking-off may be also effective to make people more familiar with the System.

The subjects of education may include the following:

(i) A statement such as “The System is intended to stop the vehicle when a passenger presses a button upon finding the driver incapacitated.”

(ii) The message may state, for example, “Press this button if you find the driver incapacitated.”

(iii) Describe the meaning of auditory and visual alerts, etc., and actions to take when they notice them, etc.

(iv) If necessary, it must be noted that a passenger pressing the activation switch does not necessarily start braking immediately, nor does it necessarily avoid all accidents.

(v) A warning must be given not to press the button out of mischief.

To the extent that it is used correctly, the person who pushes the button will not be held liable in any way for the activation of the System. The act of a passenger who presses the push button in the event of the driver's incapacity from fear of their own safety is presumably authorized as Urgent Management of Business under Article 698 of the Civil Code, holding them for no responsibility. It is not necessary for such passenger to obtain the consent of other passengers for the act of pressing the button.