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World Forum for Harmonization of Vehicle Regulations

Working Party on Lighting and Light-Signalling

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Geneva, 6 - 9 October 2009
Item 4(a) of the provisional agenda

REGULATION No. 48
(Installation of lighting and light-signalling devices)

Automatic activation of the hazard warning signal

Proposal for Supplement 5 to the 04 series of amendments to Regulation No. 48

Submitted by the expert from Japan */

The text reproduced below was prepared by the expert from Japan in order to propose conditions for automatic activation of hazard warning signal and the additional definition of "rear-end collision alert signal (RECAS)". The proposal is based on a document without symbol (informal document No. GRE-61-15), distributed during the sixty-first session of GRE (see report ECE/TRANS/WP.29/GRE/61, para. 11). The modifications to the current text of Regulation No. 48, including Supplement 3 to the 04 series of amendments, are marked in bold characters.

*/ In accordance with the programme of work of the Inland Transport Committee for 2006-2010 (ECE/TRANS/166/Add.1, programme activity 02.4), the World Forum will develop, harmonize and update Regulations in order to enhance performance of vehicles. The present document is submitted in conformity with that mandate.

A. PROPOSAL

Insert a new paragraph 2.33., to read:

"**2.33.** "**Rear-end collision alert signal (RECAS)**" **means an automatic signal given by the leading vehicle to the following vehicle. It warns that the following vehicle needs to take emergency action to avoid a collision.**"

Paragraph 5.15., amend to read:

"5.15. The colours of the light emitted by the lamps are the following:

….

emergency stop signal:	amber or red
rear-end collision alert signal:	**amber**
rear registration plate lamp:	white

…."

Insert new paragraphs 6.25. to 6.25.8., to read:

"**6.25. REAR-END COLLISION ALERT SIGNAL**

6.25.1. Presence
Optional

The rear-end collision alert signal shall be given by the simultaneous operation of all the direction indicator lamps fitted as described in paragraph 6.25.7.

6.25.2. Number
As specified in paragraph 6.5.2

6.25.3. Arrangement
As specified in paragraph 6.5.3

6.25.4. Position
As specified in paragraph 6.5.4

6.25.5. Geometric visibility
As specified in paragraph 6.5.5

6.25.6. Orientation
As specified in paragraph 6.5.6

6.25.7. Electrical connections

6.25.7.1. All the lamps of the rear-end collision alert signal shall flash in phase at a frequency of 4.0 +/- 1.0 Hz.

6.25.7.1.1. However, if any of the lamps of the rear end collision alert signal to the rear of the vehicle use filament light sources the frequency shall be 4.0 +0.0/-1.0 Hz.

6.25.7.2. The rear-end collision alert signal shall operate independently of other lamps.

6.25.7.3. The rear-end collision alert signal shall be activated and deactivated automatically.

6.25.7.4. The rear-end collision alert signal shall not be activated if the direction indicator lamps, the hazard warning signal or the emergency stop signal is activated.

6.25.7.5. The rear-end collision alert signal may only be activated under the following conditions:

Vr	**activation**
Vr > 30 km/h	**TTC ≤ 1.4**
Vr ≤ 30 km/h	**TTC ≤ 1.4 / 30 ×Vr**

"**Vr (Relative Speed)**": **means the difference in speed between a vehicle with rear-end collision alert signal and a following vehicle in the same lane.**

"**TTC (Time to collision)**": **means the estimated time for a vehicle with rear-end collision alert signal and a following vehicle to collide assuming the relative speed at the time of estimation remains constant.**

Even if the conditions are fulfilled, the signal shall not be activated if the estimated trajectory of the following vehicle indicates that no collision with the leading vehicle with rear-end collision alert signal is possible.

6.25.7.6. The activation period of the rear-end collision alert signal shall be not more than 3 seconds.

6.25.8. Tell-tale
Optional"

B. JUSTIFICATION

B.1. GENERAL PURPOSE

This proposal suggests the provision of a warning signal to the rear, activated automatically, to warn the driver of a vehicle approaching from the rear that an avoidance manoeuvre must be performed in order to avoid a collision. This warning signal, only activated under emergency conditions, would contribute to reduce the number of rear-end collisions or, at least, mitigate their consequences.

During the fifty-fifth and fifty-sixth session of GRE, the expert from Japan submitted ECE/TRANS/WP.29/GRE/2006/23 and ECE/TRANS/WP.29/GRE/2006/57 proposing conditions for automatic activation of hazard warning signal.

Based on comments received from other Contracting Parties, the expert from Japan redrafted its proposal to include a new definition of the "Rear-End Collision Alert Signal" or "RECAS" (see GRE/2007/60 submitted at the fifty-eight session of GRE in October 2007), as well as clearer activation and deactivation criteria (see GRE-61-15 submitted at the sixty-first session of GRE, March 2009). The current proposal takes into account remarks made at the meeting which, the expert from Japan hopes, will make the amendment acceptable to other Contracting Parties.

Considering the number of rear-end collisions, especially those caused by a lack of attention to, or misinterpretation of, traffic conditions, Japan believes it is appropriate to allow the automatic activation of a luminous signal, warning other road users of an imminent danger.

1. Colour and frequency of the signal

Under Regulation No. 48, the amber hazard warning signal is the most suitable signal to alert drivers of an imminent danger and trigger an immediate reaction. The hazard warning signal is universally recognized and therefore has the greatest potential to help to reduce the number of rear-end collisions resulting in injury to drivers e.g. whiplash injury.

According to investigations led in Japan, there is no significant difference whether RECAS uses a red or amber light (see Annex I). In addition, RECAS is meant to be activated automatically via a sensor, without any action from the driver such as applying the brake pedal.
Therefore, Japan would like to restrict RECAS to amber lamps only and thus bypass the legal concerns associated with the use of red lamps (automatic activation and flashing).

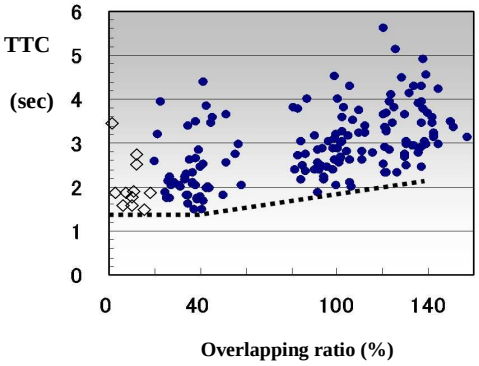
As far as the frequency is concerned, a 4 Hz signal (similar to ESS) is proven to be the most effective way to trigger other drivers' reactions compared to the regular hazard warning signal.

2. Activation criteria

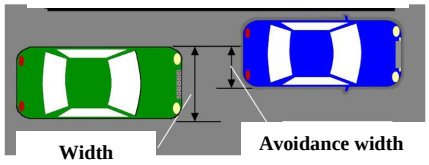
In order to contribute to improved road safety while avoiding any driver confusion or misinterpretation of RECAS, this technology must activate appropriately. The expert from Japan believes that the criteria contained in this proposal address these requirements.

Para. 6.25.7.4:
Manual or automatic activation of other functions using direction indicator lamps must take precedence over the activation of RECAS. This provision also prevents unnecessary activation, for instance when the leading vehicle changes lane, using its direction indicator.

Para. 6.25.7.5:
The intention of these requirements is to ensure that RECAS only activates in emergency situations. According to the result of the 3rd Advanced Safety Vehicle Project1/ conducted in Japan, under ordinary driving conditions, manoeuvres occur at least 1.4 seconds before a potential rear-end collision. See charts below:



Overlapping ratio:



(For details on the test protocol, see Annex II.)

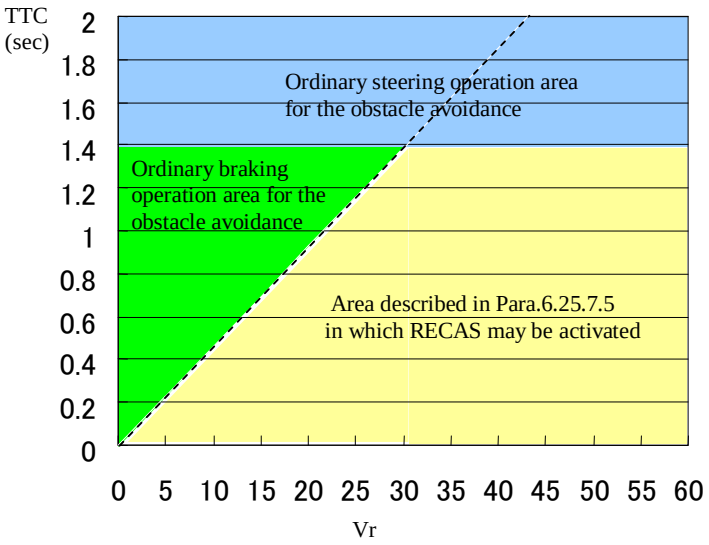
Source: Third Advanced Safety Vehicle Plan (March 2007).

According to the above results, a system which would only be activated when the Time To Collision (TTC) is below or equal to 1.4 seconds, would not have any negative influence on the regular traffic flow. However, it would remain effective in case of an emergency situation, by allowing enough time for the driver to perform a collision avoidance manoeuvre.

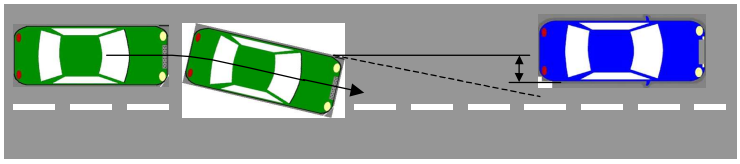
In addition, the expert from Japan proposes to introduce an additional criterion to prevent the unnecessary activation of RECAS in an urban environment, where vehicles can be driven close to each other at low speed, since it is commonly known that in such conditions, the time period for avoiding a collision by braking is shorter than the time period for avoiding a collision by steering. The expert from Japan suggests using the activation threshold for the Emergency Stop Signal (deceleration by 6 m/s^2) as a reference: when a vehicle is decelerated at 6 m/s^2, it requires approximately 1.4 seconds to go from 30 km/h to a standstill. Since slower deceleration should be considered as ordinary braking operations, RECAS shall only activate under the condition: $TTC \leq 1.4 / 30 \times Vr$.

1/ On-going since 1991, the Advanced Safety Vehicle Project conducted by the Japanese Ministry of Land, Infrastructure, Transport and Tourism aims to stimulate research and development of practical advanced safety technologies for vehicles.

See the chart below:



The last sentence of Paragraph 6.25.7.5 may not be necessary because TTC is infinity when the detection system (sensor, etc.) judges that the following vehicle will not collide with the leading vehicle, for instance, when changing lane. This requirement is included as a precaution.



These thresholds are appropriate to avoid unnecessary activation (leading to driver distrust or annoyance) and also ensure the effectiveness of the system.

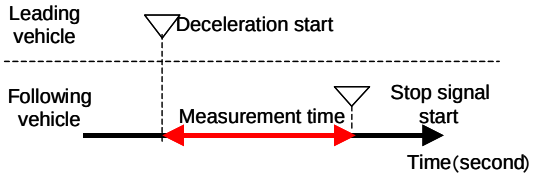
In order not to restrict the technical solutions used for the operation of RECAS systems, this proposal defines the range for activation. Manufacturers are permitted some flexibility provided the range for activation is respected.

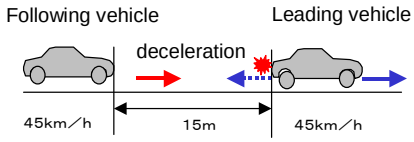
Para. 6.25.7.6.:
If a collision-avoidance manoeuvre by braking is performed when TTC is 1.4 s, it takes around 3 seconds before the relative speed becomes 0 km/h.

B.2. VEHICLE TEST OF REAR-END COLLISION ALERT SIGNAL - TEST METHOD

1. Outline

Measuring the time delay between deceleration timing of leading vehicle and stop signal start time of following vehicle.
a) Stop lamp ON (In night time = tail lamp ON, in all time = stop lamp ON)
b) stop lamp OFF (In night time = tail lamp ON)





Test pattern
Deceleration by engine braking (without stop lamp lighting)
Deceleration by engine braking + 4Hz stop lamp
Deceleration by engine braking + 4Hz hazard lamp

2. Driver's condition of following vehicle:

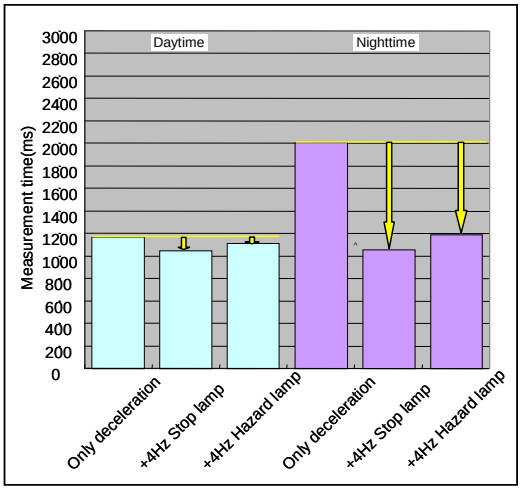
To simulate a driver who is looking ahead but is not concentrated, the driver of the following vehicle reads out the random number which is showed in centre of the table.

3. Number of tests:

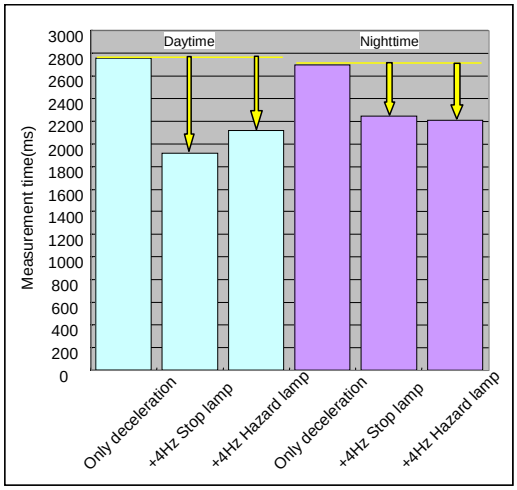
288 times = 8 (persons) per 3 (test pattern) per 3 (times/each pattern) per 2 (daytime and night time) per 2 (stop lamp ON and OFF)
a) all test patterns were conducted in random condition to avoid the expected condition.
b) all tests are conducted on the same day (order: daytime ⇒ nightime)

【Test Result】

①Stop lamp On



②Stop lamp Off



According to the test result, there is no significant difference between red and amber colours.

B.3. METHOD FOR INVESTIGATING THE TIMING WHERE DRIVERS START STEERING OPERATION TO AVOID COLLISIONS

Tests were conducted by the a Japan Automobile Research Institute (JARI), where the test vehicle was driven at a constant speed while approaching a stationary object (parked vehicle) or a moving object (vehicle travelling at low speed). The speed of the vehicle travelling at constant speed was set at three levels of 30 km/h, 60 km/h, and 90 km/h for approaching the stationary object and at three levels of 60 km/h (relative speed of 30 km/h) and 90 km/h (relative speeds of 30 km/h and 60 km/h) for approaching the moving object. In addition, by varying the lateral position of the vehicle in front for each speed condition, three levels of offset amount (minimum amount of lateral change in position required to avoid a collision) in relation to the object in front were set.

As the driving pattern, the test subjects were instructed to avoid the object by steering the vehicle to its right side at the moment when they judge that the distance between their own vehicle and the vehicle in front has decreased to the point where it becomes dangerous (i.e. that they would not approach any further in usual driving). Amount of steering operation by the driver and vehicle state quantities at this time were measured, and the relationship between each avoidance condition and timing for starting collision-avoidance steering operation was analyzed.

1. Vehicles used and test subjects

   (a) Vehicles used: Regular passenger cars, 4-door sedan (two vehicles: test vehicle and vehicle in front)
   (b) Test subjects: 16 male drivers (ages 23-59)

2. Test conditions (see Table 1)

   (a) Conditions for the stationary object (three levels)
      (i) Travelling speed (= relative speed): 30 km/h, 60 km/h, 90 km/h

   (b) Conditions for the moving object (three levels)
      (i) Relative speed of 30 km/h (own vehicle at 60 km/h and leading vehicle at 30 km/h)
      (ii) Relative speed of 30 km/h (own vehicle at 90 km/h and leading vehicle at 60 km/h)
      (iii) Relative speed of 60 km/h (own vehicle at 90 km/h and leading vehicle at 30 km/h)

   (c) Required avoidance (three levels for each of the above conditions in (a) and (b))
      (i) Over-lapping ratio */ : 40 per cent, 100 per cent, 140 per cent

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*/ Over-lapping ratio (per cent): The value obtained by dividing the amount of offset from the object by the width of the own vehicle. Since the actual over-lapping ratio at the start of collision-avoidance steering operation varies largely depending on the driving course and angle

of approach, measurement results that came within ±20per cent of the set ratio were taken as effective data.

3. Measurement items

(a) Measurement targets; the following state quantities were recorded by measuring instrument or camera installed on the test vehicle:
  (i) Amount of operation by the driver: steering angle, accelerator position, brake pedal application force;
  (ii) Vehicle state quantities: speed of own vehicle, lateral acceleration, yaw speed;
  (iii) Object in front: forward video images captured by CCD camera.

(b) Calculation targets; from the images captured by CCD camera, the following evaluation targets on the object in front were calculated:
  (i) Distance from vehicle in front: calculated from the angle of view characteristics of the CCD camera;
  (ii) Over-lapping ratio to vehicle in front: calculated from the positional relation with the vehicle in front on the analysis screen
  (iii) Relative speed to vehicle in front: calculated from changes in the vehicle distance per unit of time:
  (iv) Estimated time to collision (TTC): the value obtained by dividing the distance from the vehicle in front by the relative speed.

Table 1: Combinations of Test Conditions and Test Sequence

No.	Group A	Group B
1	100 per cent 30km/h (Stationary)	100 per cent 90km /h (Stationary)
2	100 per cent 60km/h (Stationary)	100 per cent 60km /h (Stationary)
3	100 per cent 90km/h (Stationary)	100 per cent 30km /h (Stationary)
4	40 per cent 30km/h (Stationary)	40 per cent 90km /h (Stationary)
5	40 per cent 60km/h (Stationary)	40 per cent 60km /h (Stationary)
6	40 per cent 90km/h (Stationary)	40 per cent 30km /h (Stationary)
7	140 per cent 30km/h (Stationary)	140 per cent 90km /h (Stationary)
8	140 per cent 60km/h (Stationary)	140 per cent 60km /h (Stationary)
9	140 per cent 90km/h (Stationary)	140 per cent 30km /h (Stationary)
10	100 per cent 60km/h (30km/h)	100 per cent 90km/h (30km/h)
11	100 per cent 90km/h (60km/h)	100 per cent 90km/h (60km/h)
12	100 per cent 90km/h (30km/h)	100 per cent 60km/h (30km/h)
13	40 per cent 60km/h (30km/h)	40 per cent 90km/h (30km/h)
14	40 per cent 90km/h (60km/h)	40 per cent 90km/h (60km/h)
15	40 per cent 90km/h (30km/h)	40 per cent 60km/h (30km/h)
16	140 per cent 60km/h (30km/h)	140 per cent 90km/h (30km/h)
17	140 per cent 90km/h (60km/h)	140 per cent 90km/h (60km/h)
18	140 per cent 90km/h (30km/h)	140 per cent 60km/h (30km/h)

From left to right: Over-lapping ratio, speed of own vehicle, speed of leading vehicle

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