Road vehicles - Ergonomic aspects of transport information and control systems (TICS) - Procedures for determining priority of on-board messages presented to drivers

Foreword

This standard is a automotive standard for which reference is given to ISO/TS 16951, Road vehicles - Ergonomic aspects of transport information and control systems (TICS) - Procedures for determining priority of on-board messages presented to drivers (issued as first version in 2004), and correction and addition is made in the technical contents and specified sheet format with consideration given to the conditions in Japan.

1. Scope

This standard specifies the procedures for determining the priority of on-board messages presented to driver by TICS (traveller information, navigation, travel and traffic information, "yellow pages" information, TICS warnings, systems status, emergency calling system information, and ETC) and non-TICS (telephone and warning devices). When there are mandatory or legally required messages, they shall take the priority.

Note: This standard does not specify the procedures for displaying on-board messages.

2. Terms and Definitions

Main terms and definitions used in this standard are as indicated below.

2.1

Transport information and control systems (TICS)

System comprised of an advanced information and telecommunications network for users, roads and vehicles that contributes to solving problems such as traffic accidents and congestion

Note: See **ISO/TR 14813-1** for a list of TICS service.

2.2

Contents of message

Information (warnings, alarms, operation status, etc.) provided by a TICS or conventional system (both inside and outside of the vehicle) without a specific request from the driver

Example: A message containing system status information and warnings presented using characters, symbols, figures, audible tones, voices or other means.

2.3

Criticality

Severity of damage on occupants and the vehicle caused by an accident or malfunction that can occur when the message is not received or is ignored by the driver

2.4

Urgency

Necessity level within which driver action or decision has to be taken when a message is given from the system

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2.5

Priority index

Index used to determine which messages should be given precedence when multiple messages are available for presentation

2.6

Priority

Relative importance of two or more messages which determines their rankings in a time sequence or in an identification of display

Note: The message with the highest priority is assigned first place

2.7

Weighting factor k_c

Factor of criticality used to calculate the priority index

2.8

Weighting factor k_u

Factor of urgency used to calculate the priority index

2.9

Message management system

System that controls and evaluates a wide range of information and presents it ergonomically to drivers, allowing them to cope with the information while driving and maintain safe and comfortable drive

2.10

Display

Device that allows the presentation of visual, auditory, or haptic information to a driver

2.11

Driving

Activities undertaken by the driver to navigate maneuver and handle the vehicle to control the vehicle speed and direction

2.12

Examiner

Person who manages and conducts the use of this standard for determining priority

2.13

Evaluator

Person who judges the contents of a message from the point of view of criticality and urgency to the driver

2.14

Scenario

Explanation of the driving context and situation for the message presented to evaluators

Note:

The word "*context*" used in **ISO/TS 16951** is translated to "Bunmyaku", an ergonomics term.

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3. Data collection procedure for the priority index

This clause presents the collecting method of the data used to calculate a priority index for each message.

This clause refers the example outputs given in **Annex A** and **Annex B**.

3.1 Appoint an examiner

The priority index calculation requires an examiner to prepare, analyze, and report the data. The role of the examiner is detailed in **3.6**.

The examiner shall be familiar with the priority ranking process, have knowledge on message management, and have driving experience.

If the examiner has similar qualifications to that of the evaluators, the examiner may participate as both an examiner and evaluator.

3.2 Identify and assemble messages

It is necessary for the examiner to identify messages to be evaluated in advance. The examiner shall collect the TICS and non-TICS messages and added messages from a message management system, and equally present them to the evaluators.

3.3 Define driving context and situation

For each message, the examiner shall define a driving context and situation in terms of the road environment and the traffic condition in which the message is likely to be presented.

The driving context and situation should be defined at the moment when the message is presented because the priority depends heavily on the driving context. Particular attention should be given to the presentation of messages in potentially hazardous situations. All hazardous situations should be considered, except for highly unlikely possibilities. Based on these situations the examiner may define one or more (normally not more than four) scenarios for a particular message.

The same message in two different scenarios shall be regarded as two different information items to be evaluated. This is because messages may occur in several different driving contexts, and each context could yield a different message priority. For example, the priority given to a message pertaining to a system malfunction will be different depending on whether the driver is starting the car or is relying on the system whilst driving.

If only one scenario is used for a given message, that scenario should represent a "worst-case" situation from the point of view of safety. At minimum, a TICS or non-TICS expert and the examiner should agree on the worst-case driving scenario. A traffic safety expert may also be consulted.

3.3.1 Consider the detection capability of the vehicle

The messages that are actually provided to the driver will depend on the capability of the vehicle to sense various situations. For example, if the vehicle can detect the driver's state of arousal, then the driver's state is described in the driving scenario.

For situations in which the vehicle is incapable of sensing, the message priority should be determined for a scenario representing a worst-case situation for the factors listed in **3.3.2**.

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3.3.2 Factors to consider in developing the driving scenarios

Table 1 shows the candidate factors provided to define driving context and relevant situations to which the examiner gives consideration in developing the driving scenarios. An example of context and situation factors is given in the right column. The examiner may use these or other factors to define driving scenarios. If the context cannot be categorized into one of the candidate factors listed in **Table 1**, it should be clearly described within the "Other" parentheses. If neither the context nor situation is defined for one of the factors, select "not defined (N-D)" from the list of the candidates. Then, give factors and their examples for the evaluator to easily understand the driving context and situation at the evaluation.

3.3.3 Trip context

The trip context is a factor that considers the aim of the trip (e.g. commuting, leisure, etc.), the timing or position along the route (e.g. positional relationship between start and destination etc.), and the preparatory distance to the next maneuver.

Example: "Close (e.g. 20 m) to turn (or merge, diverge)".

3.3.4 Road environment

The road environment consists of several factors, such as a static factor related to road structure that affects driving and a dynamic factor related to weather. Consideration shall also be given to the effect on driving of the surrounding environment, including such factors.

Example 1: Road structure: "highway/urban road/country road/curve/icy road /wet road", "speed limit", "number of lanes", "road width", "presence of white lines", "inside tunnel", "traffic restrictions due to dimension and weight (height limit, weight limit)"

Example 2: Weather: "rain/fog", "time of day (morning, daytime, night time, raining)"

3.3.5 Traffic situation

The traffic situation is a dynamic factor related to traffic or obstacles on the road that affects driving. Considerations here include the relationship to other vehicles, such as headway distance and speed difference to the lead vehicle.

Example 1: "Headway distance".

Example 2: "Lateral vehicle exists".

Example 3: "Speed difference to the lead vehicle".

3.3.6 Vehicle condition

This factor originates from the vehicle itself and derives from the relationship between the vehicle and the road. Vehicle condition can be separated into "vehicle type", "vehicle state", and "state of vehicle sub-system".

Example 1: Vehicle type: "passenger vehicle", "heavy vehicle".

Example 2: Vehicle state: "driving speed"; "driving in left [right] lane"; "negotiating curve [intersection]"; "position of the vehicle within a lane", "loading state (e.g. empty, half-loaded, gross vehicle weight)".

Example 3: State of vehicle subsystem: "systems check after start-up shows all systems are normal", "malfunction of system"

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3.3.7 Document the driving context and situation

The driving context and situation associated with each message scenario, and driver behaviors and/or cognitive demands assumed as a result shall be documented. An example of a driving scenario is given in **Annex A**.

Table 1 Candidate factors to consider when developing driving scenarios

Driving context/situation		Candidate factors related to context or situation
Trip context		- Close to turn (or merge, diverge) - Other (.....) - N-D
Road environment	Road structure	- Highway/urban road/country road/curve/icy road/wet road - Speed limit (.....) - Number of lanes (.....) - Road width - Presence of white lines - Inside tunnel - Traffic restrictions due to dimension and weight (height limit, weight limit) - Other (.....) - N-D
	Weather	- Rain/fog - Time of day (morning, daytime, night time, raining)" - Other (.....) - N-D
Traffic situation		- Headway distance is approx. (.....) m or (.....) s - Lateral vehicle(s) exists (yes or no) - Speed difference to the lead vehicle is approx. (.....) km/h - N-D
Vehicle condition	Type	- Passenger vehicle/heavy vehicle - Other (.....) - N-D
	Vehicle state	- Driving speed (.....) - Driving in left [right] lane - Curve (intersection) negotiation - Position of the vehicle within a lane - Loading state (e.g. empty, half-loaded, gross vehicle weight) - Other (.....) - N-D
	State of vehicle subsystem	- Systems check after start-up shows all systems are normal - (.....) Malfunction of system - provide detailed information - Other (.....) - N-D
Miscellaneous		- Driver's state of arousal - N-D

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3.4 Select the evaluators

The examiner shall select a minimum of 7 evaluators (see **4.1** and **C.2.2** in **Annex C**).

Evaluators should include experts of ergonomics and road safety, and others who possess a good understanding of the functions of the subject TICS system. They must be well-informed of the traffic environment and road environment of the subject country/region and have the ability to evaluate and take into account the safe presentation of messages. Actual use of the system is recommended for all evaluators.

The profile of each evaluator should be recorded. Profiles should include field of expertise, knowledge of road safety, ergonomics, and knowledge of the systems producing messages that are prioritized (see the example of description in **Annex D**).

3.5 Evaluate criticality and urgency of a message

The contents of messages and the driving scenarios shall be explained by the examiner in advance so that evaluators have a common understanding of the scenario, the functions of the system, and the contents of messages being examined.

Examiners shall ensure that evaluators understand the definitions of criticality and urgency, the two evaluation criteria composing the priority index. For this, evaluators must understand the four-category ordinal evaluation scales used to assign criticality and urgency (see **Tables 2 and 3**).

Each evaluator shall assign a criticality and urgency rating for each message assuming he/she is a driver.

In general, urgency will be time dependent. Controllability is one of the important factors that must be considered in determining urgency. If the situation is uncontrollable, no action shall be expected from drivers. However, if there is a possibility of controlling the situation, then urgency shall be determined depending on when the system expects drivers to take an action to handle it.

Note: See related items in the reference material "**MISRA**".

If the examiner cannot fully define the driving context and situation, evaluators shall be instructed to consider all hazardous situations, except for highly unlikely possibilities. They should assume a worst-case scenario when determining their criticality and urgency ratings.

Note: Initially, three rating scales were used in calculating a priority index. See **Annex E** for the reason for reducing the number of rating scales to two.

3.6 Instructions for the examiner

The role of the examiner is to

- **a)** record information about each evaluator in the evaluator profile (see **Annex D**),
- **b)** create the questionnaire according to **Annex A** for the vehicle and system to be evaluated, and distribute the questionnaire and **Tables 2 and 3** to each evaluator (definitions of criticality and urgency should be provided with the questionnaire),
- **c)** explain the evaluation items and the contents of the message(s) in the questionnaire to the evaluators, while providing a means for evaluators to record the driving context and situation they used in making their evaluations, whenever the examiner's description was not clear or sufficient,
- **d)** explain the classification of criticality and urgency according to **Tables 2 and 3**,
- **e)** explain how to record the rating for criticality and urgency in the applicable column of the questionnaire,
- **f)** collect the questionnaire, and
- **g)** analyze the data and report the results.

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Table 2 Criticality rating scale

Rating	Risk to vehicle, occupants and/or pedestrians	Examples
3	Severe or fatal injury	- Ignoring speed warning when driving significantly above the speed limit. - Collision as a result of loss of braking due to ignoring the brake failure warning. - Collision at high speed. - Leaving the roadway, head-on collision and collision with structures at intermediate speed. - Following vehicle ahead too closely at high speed.
2	Injury or possible injury	- Risk of collision due to following a vehicle ahead too closely at intermediate speed. - Vehicle(side)-to-vehicle(side) collision or vehicle leaving the road due to ignoring collision warning at intermediate or low speed, and head-on collision and collision with structures at intermediate or low speed.
1	No injury (vehicle damaged)	- Vehicle-to-vehicle collision except head-on collision at low speed. - Following vehicle ahead too closely at low speed. - Collision with structures at low speed.
0	No injury (no vehicle damaged)	- Vehicle-to-vehicle contact at very low speed. - Collision with structures at very low speed.
Note 1: Only a few examples are shown above. These can be expected to vary in criticality from region to region depending on the road environment and other situational and contextual factors. Therefore, examiners are able to alter them at their discretion. **Note 2:** The examples shown here illustrate that a warning message can be assigned a high criticality rating, even if failure to respond to the warning does not result in a crash. **Note 3:** Driving speeds vary by country. The speed values (km/h) for “very low,” “low,” “intermediate,” and “high” speed will depend on the country and on elements of the driving scenario such as urban, suburban, or expressway roads.		

Table 3 Urgency rating scale

Rating	Description	Examples
3	Respond immediately Take immediate action or decision (within zero to three seconds) according to the displayed information.	- Obstacle immediately in the vehicle path. Brake immediately. Steer to avoid dangerous situations. - ACC[a)] malfunctioning.
2	Respond within a few seconds Take action or decision according to the displayed information within 3 to 10 seconds [1].	- Obstacle within a few seconds in the vehicle path. Brake in a few seconds. Steer away from danger as required.
1	Response preparation Prepare to take action or decision according to the displayed information within 10 seconds to 2 minutes.	- Onset of detection of an obstacle.
0	Information only No direct action or decision required by driver	- System on.
Note: [a)] adaptive cruise control		

4. Data analysis for priority index

4.1 General

This clause provides a method for calculating the message priority index based on evaluator ratings of criticality (c_i) and urgency (u_i).

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Since the priority index for each message is obtained by averaging the priority indexes of each evaluator, the number of evaluators affects the reliability of the overall index. Therefore, ten or more evaluators are desirable in order to make the priority index reliable (See **Annex C**). However, fewer than ten evaluators are acceptable if the standard deviation across evaluators is small enough[1)]. **Annex F** contains an example procedure for determining acceptable standard deviations. In all cases, the minimum number of evaluators should be seven, to avoid bias by the selection of evaluators.

Note: [1)]

The definition of "small enough" deviation is currently under discussion.

4.2 Select weighting factors

In order to use this standard, those involved in the design of the message management system need numerical values of k_c and k_u as the first step. When there is no established rule to determine k_c and k_u, one way is to assign 1.0 to k_c and k_u, making criticality and urgency equally important. Another way is to obtain k_c and k_u based on empirical data. An example of the method is shown in **Annex G**. This example indicates that $k_u = k_c = 1.0$ can be used as rounded values for the weighting factors. The evaluator's ratings of criticality (c_i) and urgency (u_i) given in **Clause 3** are used to calculate priority index P_j in **4.4** [see Equation (2)]. As the ratings range between 0 and 3 for both criticality and urgency (see **Tables 2 and 3**), $k_u = k_c = 1.0$ means that the contribution of criticality and urgency to the priority index would be the same, and adopting the value is recommended.

4.3 Calculate priority index p_{ij}

Priority index p_{ij} indicates the relative importance of the *i*th evaluator and *j*th message and is calculated according to the following equation (1).

$$p_{ij} = k_c c_{ij} + k_u u_{ij} \qquad (1)$$

where, p_{ij}: is the individual value for priority index;

c_{ij}, u_{ij}: are the individual ratings, respectively, of criticality and urgency; and

k_c, k_u: are weighting factors respectively of criticality and urgency against p_i (see **4.2**).

4.4 Calculate arithmetic mean and standard deviation of priority index across evaluators for each message

The arithmetic mean P_j obtained by equation (2), is the priority index, which indicates the relative importance of the *j*th message:

$$\begin{aligned} P_j &= \sum_{i=1}^{n} p_{ij} / n \\ &= \sum_{i=1}^{n} \left(k_c c_{ij} + k_u u_{ij}\right) / n \\ &= k_c C_j + k_u U_j \end{aligned} \qquad (2)$$

where P_j: is the priority index of the *j*th message;

C_j, U_j: are the mean score across evaluators, respectively, of criticality and urgency of the *j*th message;

n: is the number of evaluators.

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