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Road vehicles — Ergonomic aspects of transport information and control systems — Specifications and compliance procedures for in-vehicle auditory presentation

Véhicules routiers — Aspects ergonomiques des systèmes de commande et d'information du transport — Spécifications et modes opératoires de conformité concernant la présentation des informations auditives à bord du véhicule

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 15006 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 13, *Ergonomics applicable to road vehicles*.

Introduction

The driver and the vehicle are an integrated system that includes the environment, the primary vehicle controls, the instrumentation, and the transport information and control systems (TICS). The driving task, and human capabilities and limitations, are other primary factors. TICS are intended to support the driver in her/his primary task, and therefore it is expected that the overall workload of the driver will not be negatively influenced, while performance and comfort should be increased.

The multitude of information to be displayed to the driver through TICS may create the need to minimize visual load and make more and better use of the auditory channel. This standard provides ergonomic specifications for the design and installation of auditory displays presenting speech and tonal information while driving. The aim of these specifications is to help designers to provide auditory messages which meet usability, comfort and safety criteria.

Road vehicles — Ergonomic aspects of transport information and control systems — Specifications and compliance procedures for in-vehicle auditory presentation

1 Scope

This International Standard establishes ergonomic specifications for the presentation of auditory information related to transport information and control systems (TICS) through speech or sounds. It applies only to the use of auditory displays when the vehicle is in motion. It presents a set of requirements and recommendations for in-vehicle auditory messages from TICS, and provides message characteristics and functional factors for maximizing message intelligibility and utility while helping prevent auditory or mental overload.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5128, *Acoustics — Measurement of noise inside motor vehicles*

ISO 11429, *Ergonomics — System of auditory and visual danger and information signals*

ISO/TS 16951[1)], *Road vehicles — Criteria for determining priority of TICS and other messages presented to drivers*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
audibility
percentage of persons who are able to detect an auditory signal within a defined acoustical environment

3.2
comprehensibility
degree to which information conveyed to the driver is understood

3.3
loudness
sensation (perception) that is most closely related to the sound amplitude of an acoustical stimulus

3.4
orienting reaction
human behaviour in response to the novelty of a stimulus

NOTE If, in a given situation, factual and expected stimuli do not match, an orienting behaviour is released which in its amplitude is proportional to the degree of the stimulus' novelty. With increasing stimulus intensity, this behaviour changes to defensive reactions. In the case of very high and sharp stimuli, a startle reflex is released.

1) To be published.

3.5
perceptual discriminability
signal properties of a tonal signal which allow reliable classification of each signal in a given set of signals

3.6
safety critical message
message requiring immediate action by the driver in order to avoid imminent danger to persons or very serious damage to equipment

3.7
signal-to-noise ratio
SNR
ratio of signal intensity to noise intensity in octave (or one-third octave) bands

3.8
tonal signal
auditory signal with no identifiable spoken item

3.9
simple vocabulary
words commonly used and easily understood

4 Signal specifications

4.1 Signal spectrum — Recommendation

The recommended frequency range for in-vehicle auditory speech signals is 200 Hz to 8 000 Hz. For tonal signals, the recommended range lies between 400 Hz and 4 000 Hz. Pure tones should be avoided because standing wave patterns cause resonance and anti-resonance areas so that the audibility of a signal at the driver's head cannot be guaranteed. A broad band sound or a mix of narrow band sounds, with distinctly separated centre frequencies, should be used.

EXAMPLE A mix of two bands of frequency, one centred around 800 Hz, and the other centred around 3 000 Hz.

Good practice in measuring and evaluating the signal is provided in Annex A.

4.2 Signal levels

4.2.1 General

The selection of optimal sound amplitude is a matter of balancing listener comfort against message audibility. The latter is primarily a function of the signal-to-noise ratio (SNR) between the signal and the background noise. It should be kept in mind that loudness depends on the level of the background noise and on the level of the signal within a given frequency band. Therefore, loudness at a given SNR increases with a rising background noise. In a long-term perspective, the SNR should be replaced by measures of loudness.

NOTE Methods for measuring loudness are given in ISO 532.

4.2.2 Audibility — Recommendation

The main criterion for selecting a signal level is obtaining maximum audibility, measured against the specific background noise within a driving vehicle. For in-vehicle signals, audibility should be as high as possible (usually 95 %). To reach this criterion, a loudness range between 50 dB(A-weighted) and 90 dB(A-weighted) should be used. Signal levels higher than 90 dB(A-weighted) should be avoided (see ISO 5128). In the normal case, an SNR of about 5 dB(A-weighted) ought to be sufficient to guarantee audibility. SNR values of 15 dB(A-weighted) and more should be avoided.

NOTE The expression “dB(A)” is used in industry but its use is not recommended. IEC 61672-1 gives details of A-weighting.

4.2.3 Appropriateness — Recommendation

Signal levels which are too high, unexpected signals or unknown signals, could lead to defensive reactions or startle reflexes inappropriate for safe driving. A gradual onset not higher than 1 dB/ms is recommended.

— 1 dB/ms is appropriate for messages requiring immediate driver attention, because a warning has to be issued and an immediate reaction is necessary [the relevant rise time is only 50 ms for the maximum SNR of 50 dB(A-weighted)].

— For less urgent messages, the rate of rise can be reduced to 0,75 dB/ms or 0,5 dB/ms, as only audibility and distinctness of the signal have to be guaranteed. If the presentation of the message has to be delayed and reaction to it is therefore urgent, the rate of rise for short-term messages should be applied.

— The rate of rise has no psychological relevance for messages where there is no urgency and the slope could be reduced by up to 0,33 dB/ms without creating problems (maximum relevant rise time: 150 ms). This would result in a pleasant onset of the signal and the perceived sound quality would mainly depend on other characteristics of the sound.

4.2.4 Flexibility of the signal level — Recommendation

Because of the large variation in background noise and large individual differences in the hearing capabilities of the drivers, there is a need for flexibility of the signal level. Therefore:

— the signal level should be adjustable within a range of ± 10 dB(A-weighted) about a nominally audible level;

— apart from safety critical messages, it should be possible to switch auditory displays on or off;

— the level should be automatically adjustable to the frequency spectrum of the background noise;

— a frequency-specific amplification should be provided which allows the driver to adapt the signal to her/his hearing capabilities, especially for speech signals.

5 Coding of information

5.1 General

Information may be delivered using speech or non-speech coding or by a combination of both according to the temporal characteristics of the message.

5.2 Temporal classification of signals — Recommendation

Signals should be classified according to the urgency (see ISO/TS 16951) of the intended driver's action. To differentiate between the time categories, different patterns of acoustical parameters can be chosen (e.g. sound level, frequency, see 5.3). Three time categories seem to be justified.

a) **"Short-term" category**: immediate action required. The message should be sent to the driver immediately after the critical event is detected by the TICS.

EXAMPLE An obstacle on the road is detected. The driver is warned to take evasive action immediately.

b) **"Medium-term" category**: the action should take place within a short time (10 s to 20 s). Messages in this category may be sent with a time delay.

EXAMPLE Route-guidance information.

c) **"Long-term" category**: a future behaviour is expected. Messages in this category may be sent with a time delay. The time within which the driver reacts to the message may be chosen within broader limits.

EXAMPLE Congestion 10 km ahead.