International Telecommunication Union

ITU-T FG Distraction

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ITU-T Focus Group on Driver Distraction

Report on User Interface Requirements for Automotive Applications

Focus Group Technical Report

ITU-T

ITU International Telecommunication Union

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The procedures for establishment of focus groups are defined in Recommendation ITU-T A.7. The ITU-T Focus Group on Driver Distraction (FG Distraction) was established further to ITU-T TSAG agreement at its meeting in Geneva, 8-11 February 2011. ITU-T Study Group 12 is the parent group of FG Distraction.

Deliverables of focus groups can take the form of technical reports, specifications, etc. and aim to provide material for consideration by the parent group in its standardization activities. Deliverables of focus groups are not ITU-T Recommendations.

SERIES OF FG DISTRACTION TECHNICAL REPORTS

Final Report

Report on Use Cases

Report on User Interface Requirements for Automotive Applications

Report on Situational Awareness Management

Report on Vehicle-to-Applications Communications Interface

ABSTRACT

*This report proposes a structure and initial content for draft new Recommendation ITU-T P.UIA (*User Interface requirements for Automotive applications*). P.UIA will give guidance to ICT application authors, system architects, and device manufacturers on how to design their products to enhance the driver's Situational Awareness (SA). A structure for P.UIA is proposed which can easily scale to reflect the latest in what is known to be good design practice and performance. Existing works and on-going activities related to P.UIA are also identified.*

Table of Contents

1. Scope

A structure for draft new Recommendation ITU-T P.UIA (User Interface requirements for Automotive applications) is proposed in this report. Initial content based on industry accepted guidelines is also given. P.UIA will provide guidance to Information and Communications Technologies (ICTs) application authors, system architects, and device manufacturers on how to design their products for safe interaction with drivers of road vehicles.

Both system-level (i.e., Driver-to-Application) and subsystem (e.g., Driver Vehicle Interface, nomadic device, etc.) recommendations will be given. All modalities (visual, auditory, tactile, manual input, speech input) are considered within scope, and performance recommendations will apply regardless of device type (e.g., vehicle, nomadic-paired, nomadic-not paired).

P.UIA is intended to apply to non-commercial road vehicles. Commercial road vehicles may have additional requirements not considered. Advanced Driver Assistance Systems (ADAS) are considered out of scope.

2. References

[1] U.S. Department of Transportation, 2012. *Visual-Manual NHTSA Driver Distraction Guidelines for In-Vehicle Electronic Devices* (Docket No. NHTSA-2010-0053), Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration.

[2] ETSI TR 102 762 V1.1.1 (2010-04): *Human Factors (HF); Intelligent Transport Systems (ITS); ICT in cars*. http://www.etsi.org/deliver/etsi_tr/102700_102799/102762/01.01.01_60/tr_102762v010101p.pdf

[3] Car Connectivity Consortium Driver Distraction Guidelines. http://www.mirrorlink.com/

3. Definitions

ADAS – Advanced Driver Assistance Systems are vehicle systems which have a primary function of helping the driver safely control the vehicle. Examples of such systems include lane departure warning systems and Adaptive Cruise Control (ACC).

Commercial road vehicle – a vehicle used by businesses or public transportation authorities which as a primary function other than personal transportation of individuals or small groups of individuals. Examples include tractor-trailers and buses. Such vehicles often require drivers to perform additional tasks while driving which may not have been adequately considered during the development of this report.

Driver-Vehicle Interface (DVI) – the integrated user interface in the vehicle. It includes visual displays, loudspeakers, microphones, manual input controls, etc.

Nomadic device – a portable ICT device brought into the vehicle. Examples include mobile phones and Portable Navigation Devices (PNDs).

4. Abbreviations

ADAS	Advanced Driver Assistance Systems
AppSS	Application SubSystem
CCC	Car Connectivity Consortium
DVI	Driver Vehicle Interface
ETSI	European Telecommunications Standards Institute
G.SAM	Draft new Recommendation ITU-T G.SAM
G.V2A	Draft new Recommendation ITU-T G.V2A

HFCV	Human Factors Connected Vehicle
HMI	Human-Machine Interaction
ICT	Information and Communications Technology
ISO	International Organization for Standardization
ITU-T	Standardization sector of the International Telecommunications Union
NetSS	Network SubSystem
NDSS	Nomadic Device SubSystem
NHTSA	National Highway Transportation Safety Administration
P.UIA	Draft new Recommendation ITU-T P.UIA
QoS	Quality of Service
SAE	Society of Automobile Engineers
SDO	Standards Development Organization
SHRP2	Strategic Highway Research Program 2
TRB	Transportation Research Board
UNECE	United Nations Economic Commission for Europe
VCSS	Vehicle Cockpit SubSystem

5. Introduction

The automotive cockpit is fundamentally changing. ICTs are finding their way into road vehicles and drivers are increasing interacting with these vehicle-installed, nomadic, and cloud-based ICT systems. This has the potential to cause a significant increase in technology-related driver distraction and workload. There is a growing need to provide designers and developers of ICT applications and systems with guidance for safely interacting with drivers.

Currently, there is no single place for the ICTs community to go for comprehensive guidance on this topic. However, work has recently started within Question 4 (*Hands-free communication and user interfaces in vehicles*) of ITU-T Study Group 12 (*Performance, QoS and QoE*) to create draft new Recommendation ITU-T P.UIA (*User Interface requirements for Automotive applications*). P.UIA will address this need by providing references to existing guidelines and standards. It may also include new guidance not found elsewhere, but which is supported by research data and consensus among experts.

This purpose of this report is to propose a structure for P.UIA which makes it easy for the ICTs community to find the information they need. The proposed structure can also easily scale to reflect the latest research findings and current guidelines/standards. Initial content for P.UIA based on industry accepted guidelines is also proposed.

Section 3 of this report describes the proposed structure for P.UIA. Section 4 provides information on currently accepted industry standards that can serve as the basis for P.UIA. Section 5 discusses additional existing works that are relevant to P.UIA. Section 6 lists some related on-going activities that should be considered during the standardization of P.UIA.

6. Proposed P.UIA structure

It is proposed that P.UIA provide guidance on both the end-to-end system (i.e., application-to-driver) and the following subsystems (see Figure 1):

1) Application SubSystem (AppSS)
2) Network SubSystem (NetSS)

3) Vehicle Cockpit SubSystem (VCSS)

4) Nomadic Device SubSystem (NDSS)

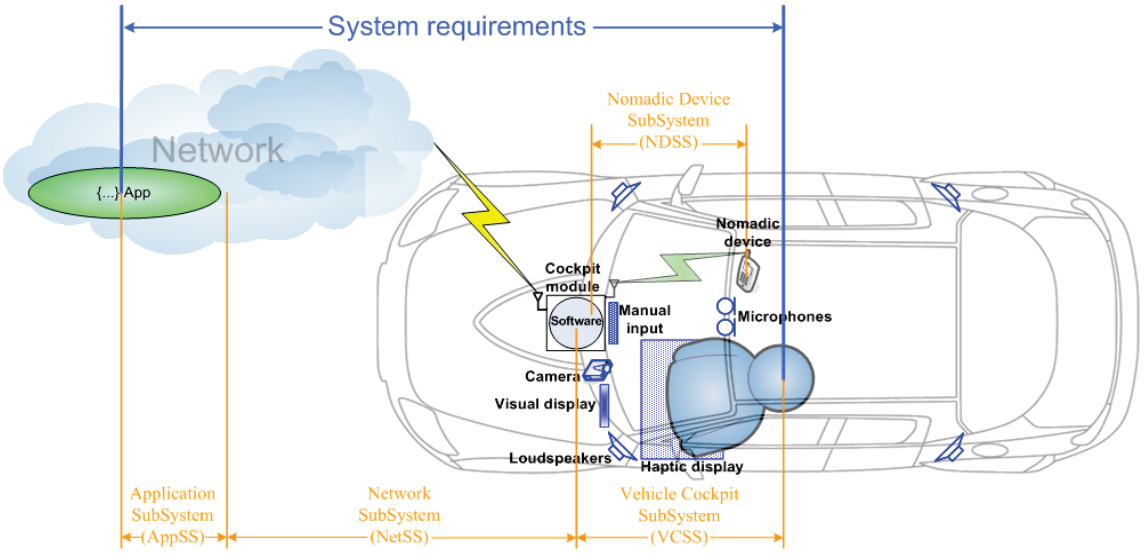

Figure 1. Subsystems that are addressed by this Recommendation.

It is also proposed that guidance be further grouped based on timing relative to the onset of engagement. There are 3 such groups:

1) **Strategic** – recommendations that influence drivers' decisions to engage, or not to engage, in activities. They deal with long timeframes on the order of minutes to never.

2) **Tactical** – recommendations that support drivers' decisions on when to engage. They target medium timeframes on the order of seconds to minutes.

3) **Operational** – recommendations that optimize human-machine interactions during engagement. They target timeframes on the order of milliseconds to seconds.

The timings associated with these groups are illustrated in Figure 2.

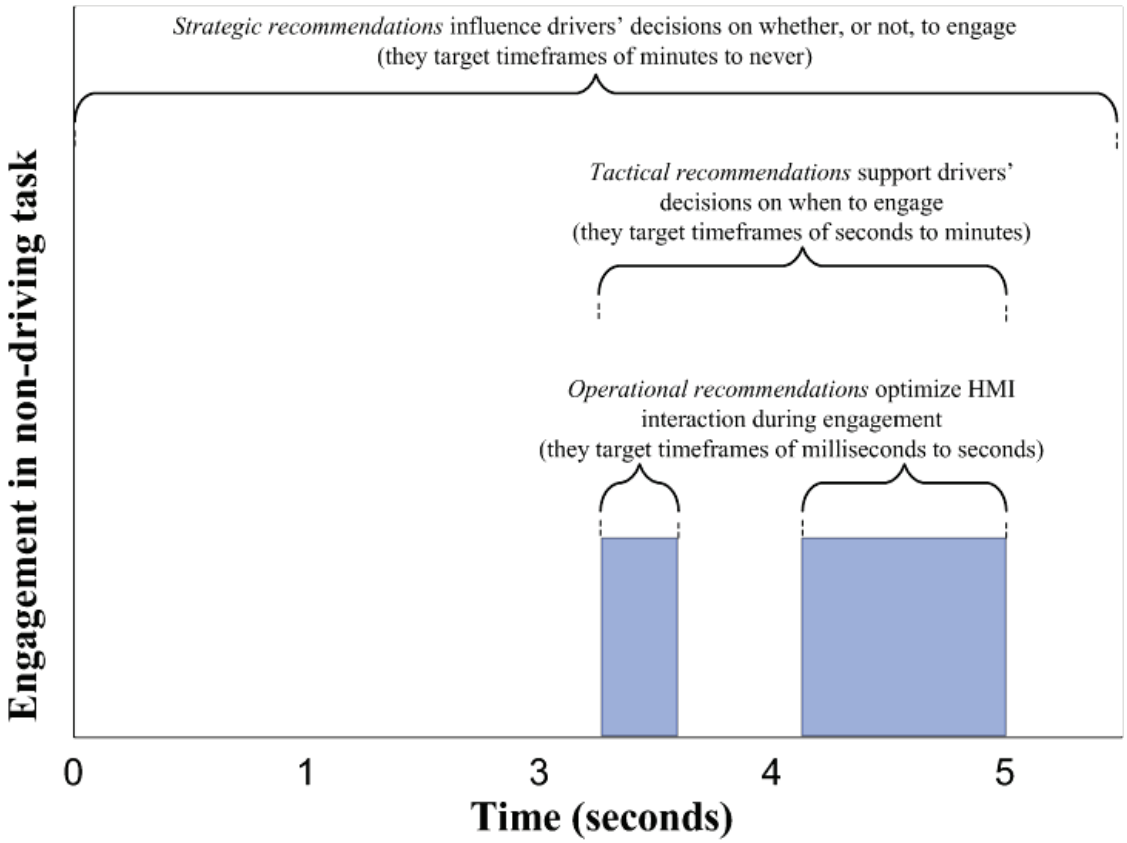

Figure 2. Timings used to group recommendations.

Operational recommendations can be further grouped based on the aspects of human-machine interaction (HMI) that they address. Below is the list of subgroups for operational recommendations:

a. Messages to Driver
    i. Visual messages
    ii. Auditory messages
    iii. Haptic messages
    iv. Multi-modal messages
b. Input from Driver
    i. Speech input
    ii. Manual control input
    iii. Gesture input
    iv. Multi-modal input
c. Dialogue
d. Menu structure

All of these groupings are helpful for a couple of reasons. First, each grouping addresses a distinctly different type of functionality from the designer's perspective. Therefore, these groupings help designers quickly find the set of recommendations that they are working on at any given time. Second, recommendations within each group address aspects of human-machine interaction that are related. Having them grouped together makes it easier to optimize human-machine interaction.

There are several different forms that guidance can take. They are described below:

a. **Guideline (G)** – Refers to guidance where there is not always a clear right or wrong answer; or it is difficult to specify.

b. **Performance requirement (P)** – Refers to a level of performance, as opposed to a specific design implementation, which can be verified using a measurement method and pass/fail criteria. Measurements can be made using either objective (i.e., physical equipment as measuring device) or subjective (i.e., users as measuring device) measurement techniques.

c. **Functional requirement (F)** – Refers to specific functionality that can be verified through measurement or observation.

d. **Design requirement (D)** – Refers to specific design implementation that can be verified through measurement or observation.

e. **Tip (T)** – Refers to design suggestions to achieve a performance or functional requirement.

Annex A shows what the P.UIA structure might look like. This proposed structure and format will enable P.UIA to easily scale to accommodate:

- New standards from other Standards Development Organizations (SDOs)
- New information from basic research and naturalistic studies
- Future devices, systems, and technology

It is anticipated that draft new Recommendation ITU-T P.UIA will become a living document with regular revisions to keep it up-to-date. Attempts should be made to leverage and harmonize regional standards whenever possible. Harmonization can sometimes be achieved by specifying a commonly agreed test method and enumerating different pass/fail thresholds for different regional authorities.

7. Starting point for P.UIA

There was agreement within FG Distraction that the starting point for P.UIA should be based on the currently accepted industry standards. These are described in Annex B of this report. It should be mentioned that the Alliance of Automobile Manufacturers (Alliance) have expressed concern that it may be difficult, or even not possible, to appropriately map the existing guidelines/standards in Annex B into the structure proposed in Annex A. They have stated that:

"*A reorganization of these existing guidelines into a new and more complex structure will have the potential to unnecessarily introduce errors and may not fully comprehend the regional differences that exist in terms of cultural specific requirements and verification procedures. Furthermore, adoption and integration of new and revised HMI guidelines into the ITU-T structure will require significant ITU-T resources. Such new guidelines could be referenced in P.UIA more quickly and would not risk introduction of possible errors in the process of reorganization and interpretation*."

8. Existing works

In addition to those referenced in Annex B, below are some additional existing works that should be considered during the development of P.UIA:

- **NHTSA visual-manual guidelines docket** [1] – informative public comment on the NHTSA visual-manual guidelines can be found here.
- **ETSI report on ICT in cars** [2] – technical report from ETSI on the factors important for safe interaction of drivers with ICT applications/systems. A summary of existing work in this area is also provided.
- **Car Connectivity Consortium (CCC) Driver Distraction guidelines** [3] – represents industry attempt to adapt guidelines referenced in Annex B to application subsystem.

9. Ongoing activities

Below are some on-going activities that should be considered during the development of P.UIA:

- **Alliance visual-manual guidelines update** – The Alliance has indicated that they may update their visual-manual guidelines.
- **Human Factors Connected Vehicle (HFCV) guidelines** – NHTSA has contracted Battelle to develop some HMI guidelines for connected vehicles. More information can be found at: http://projects.battelle.org/auto-ui12-hfcvworkshop/schedule.html .
- **ISO TC 22/SC 13/ WG 8** – this group is made up of subject matter experts on automotive HMI and well represented by academia and automakers. More information can be found at: http://www.iso.org/iso/iso_technical_committee.html?commid=46880. They are actively working on guidelines and standards related to P.UIA including the following:
  - **Detection Response Task (WD 17488)** – Promising new measure of driver distraction and workload that is currently under development.
- **NHTSA Phase 2 (nomadic visual-manual) & 3 (voice user interface) guidelines** – NHTSA is planning to release visual-manual guidelines for nomadic devices in Phase 2 and voice user interface guidelines that apply to all device types in Phase 3. More information can be found at: http://www.nhtsa.gov/ .
- **SAE Safety & Human Factors Steering Committee DVI committee** – this group is made up of subject matter experts on automotive HMI and well represented by academia and automakers. More information can be found at: http://www.sae.org/works/committeeHome.do?comtID=TEITSSHF . They are actively working on guidelines and standards related to P.UIA including the following:
  - **Voice User Interface Principles informational report** – informational report expected latter in 2013 that will provide guidelines on speech interfaces for interacting with applications.
  - **Task Force #1 (Research Foundations and Outreach)** – this group is "*Responsible for cataloging, summarizing and maintaining all published data sources (e.g., papers, articles, citations, etc.) on Driver Vehicle Interface (DVI) design, and related data sources on driver distraction.*".
- **UNECE WP.29 ITS informal group** – UNECE WP.29 is the UN agency dealing with international vehicle regulations. It plays a very similar role to that of the ITU-T – except that it deals with vehicle regulations instead of telecommunications standards. The ITS informal group is working on issues related automotive HMI standards. More information can be found at: http://www.unece.org/trans/main/welcwp29.html.
- **SHRP2 project** –Large scale naturalistic driving study being conducted by the Transportation Research Board (TRB) that is expected to provide insight into the factors contributing to near-crashes and crashes. More information can found at: http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-S05-RR-1.pdf.

Bibliography

Regan, M.A., Lee, J.D., and Young, K.L. (Eds.). (2009), *Driver Distraction: Theory, Effects, and Mitigation*. Boca Raton, FL: CRC Press.

Annex A

(Draft structure for P.UIA)

1. Introduction

2. System level recommendations (i.e., Application-to-Driver)

2.1 Strategic recommendations

2.1.x Strategic recommendation x (e.g., Risk awareness messages)

INSERT G.x, P.x, F.x, D.x, T.x

2.2 Tactical recommendations

2.2.x Tactical recommendation x (e.g., Make applications ignorable)

INSERT G.x, P.x, F.x, D.x, T.x

2.3 Operational recommendations

2.3.1 Messages to Driver

2.3.1.1 Visual messages

2.3.1.1x Visual message recommendation x (e.g., Max. eye glance duration)

INSERT G.x, P.x, F.x, D.x, T.x

2.3.1.2 Auditory messages

2.3.1.2x Auditory message recommendation x

INSERT G.x, P.x, F.x, D.x, T.x

2.3.1.3 Haptic messages

2.3.1.3x Haptic message recommendation x

INSERT G.x, P.x, F.x, D.x, T.x

2.3.1.4 Multi-modal messages

2.3.1.4x Multi-modal message recommendation x

INSERT G.x, P.x, F.x, D.x, T.x

2.3.2 Input from Driver

2.3.2.1 Speech input

2.3.2.1x Speech input recommendation x

INSERT G.x, P.x, F.x, D.x, T.x

2.3.2.2 Manual control input

2.3.2.2x Manual control input recommendation x

INSERT G.x, P.x, F.x, D.x, T.x

2.3.2.3 Gesture input

2.3.2.3x Gesture input recommendation x

INSERT G.x, P.x, F.x, D.x, T.x

2.3.2.4 Multi-modal input

2.3.2.4x Multi-modal input recommendation x

INSERT G.x, P.x, F.x, D.x, T.x

2.3.3 Dialogue

2.3.3.x Dialogue recommendation x

INSERT G.x, P.x, F.x, D.x, T.x

2.3.4 Menu structure

2.3.4.x Menu structure recommendation x

INSERT G.x, P.x, F.x, D.x, T.x

3. Application SubSystem (AppSS) recommendations

INSERT STRUCTURE FROM SECTION 2 HERE AND ADAPT TO THIS SS

4. Network SubSystem (NetSS) recommendations

INSERT STRUCTURE FROM SECTION 2 HERE AND ADAPT TO THIS SS

5. Vehicle Cockpit SubSystem (VCSS) recommendations

INSERT STRUCTURE FROM SECTION 2 HERE AND ADAPT TO THIS SS

6. Nomadic Device SubSystem (ND SS) recommendations

INSERT STRUCTURE FROM SECTION 2 HERE AND ADAPT TO THIS SS

Annex A

(Rationale for P.UIA recommendations)

INSERT RATIONALE FOR SPECIFIC RECOMMENDATIONS HERE

Annex B

(Existing standards to serve as starting point in development of P.UIA)

Compendium of International Standards and Guidelines

Governing the Driver Interface for Telematics Devices

For Use in the Driving Environment

The importance of a safe human machine interaction (HMI) for in-vehicle information, control, and communication systems has been addressed by the development of safety guidelines, standards, and regulations that have evolved as the complexity of the driver cockpit has increased. With the increased penetration of both integrated and nomadic telematics devices, government and industry have appropriately responded with the generation of applicable guidelines covering the visual-manual driver vehicle interface. With the increasing use of voice interfaces industry standards organizations (e.g., SAE) are currently working to develop guidelines in this area as well. In addition the National Highway Traffic Safety Administration (NHTSA) has announced its intention to issue voluntary guidelines covering vehicle integrated visual/manual, nomadic visual/manual, and voice driver/vehicle interfaces over the next few years[1].

Currently there are three main sets of guidelines applicable to visual-manual driver interfaces that industry has committed to use; JAMA (Japan Automobile Manufacturers Association) Guideline for In-Vehicle Display Systems, Version 3.0[2], Alliance of Automobile Manufacturers Statement of Principles, Criteria and Verification Procedures on Driver Interactions with Advanced In-Vehicle Information and Communication Systems, June 26, 2006[3], Commission of the European Communities (2007) Commission Recommendation on Safe and Efficient In-Vehicle Information and Communication Systems; Update of the European Statement of Principles on Human Machine Interface[4].

While each of these sets of guidelines are substantially similar, there are some differences regarding scope, aspects of performance, and degree at which verifications procedures are provided. These are summarized in table 1. It should also be recognized that where guidelines differ for an aspect of performance the performance guidance provided by the guidelines endorsed by that regional authority (e.g., JMIT, EC, etc.) should take preference for vehicles produced for sale in that jurisdiction.

As indicated above, for vehicles sold in the United States the NHTSA is in the process of issuing "voluntary" visual-manual guidelines for vehicle integrated systems. Once this document is completed, it is expected that it will be added to the list of guidelines applicable to visual-manual interfaces. Likewise any voice interface guidelines developed by NHTSA would also be added to the list of applicable voice interface guidelines.

There are many additional human factors standards and guidelines that address specific aspects of human interface performance with vehicle controls, displays, and communications devices. However, these do not currently directly impact vehicle design to the level achieved by the three main guidelines detailed above. While not an exhaustive list, we have provided as a reference a listing of some of the more relevant guidelines as an attachment to this document.

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[1] Cite section of DOT distraction plan that details these activities

[2] Cite Japanese guideline and location where it can be obtained

[3] Cite US guideline and location where it can be obtained

[4] Cite ECE statements of principles

Table 1. - Vehicle Integrated Telematics Visual-Manual Driver Interface Guidelines (Currently in practice either by voluntary commitment or national regulation)

Aspect of Performance	Japan (JAMA)[5]		United States "Alliance"[6]		ECE ESoP	
	Principle/ Requirement	Verification procedure	Principle/ Requirement	Verification Procedure	Principle/ Requirement	Verification Procedure
Correct installation	3.	None provided	1.1	Design to conform and validate by appropriate means	4.3.2.1	Inspection per referenced standards
Driver field of view	3.1(2) 5(2)	None Provided (3.1(2) Annex 3 (5(2))	1.2	Design to conform and validate by appropriate means	4.3.2.2	Inspection or measurement per referenced standards
Obstruction of controls	3.1(1)	None provided	1.3	Design to conform and validate by appropriate means	4.3.2.3 4.3.4.5	Inspection per referenced standards
Ability to maintain normal driving posture to operate display system	3.1(3)	None provided				
Retrofit installation	3.1(4)	None Provided				
Close to the drivers line of sight	3.2	Annex 1	1.4 (A or B)	Detailed procedures provided	4.3.2.4	Judgement by designers and ergonomics specialists
Reflections	3.2	None provided	1.5	Verification should be done by appropriate means	4.3.2.5	Based on appropriate procedures to determine reflections and glare (not specified)
Short glances	4.2(1)(2)	Annex 2	2.1A[7]	Detailed procedures provided	4.3.3.1	Comparison of design alternative to minimize number and duration of glances
Total glance time	4.2(1)(2) 5(3)	Annex 2 (4.2(1)(2) Annex 3 (5(3))	2.1A[7]	Detailed procedures provided	4.3.3.1	Comparison of design alternative to minimize number and duration of glances
Visual distraction / driving performance			2.1B[7]	Detailed procedures provided		
Symbole	4.1(2)	None provided	2.2	Design to conform	4.3.3.2	Inspection to referenced standards
Legibility	4.1(2)	None provided	2.2[8]	Design to conform	4.3.3.2	Inspection to referenced standards
- Contrast	4.1(2)	None provided	2.2[8]	Design to conform	4.3.3.2[8]	Detailed measurements are

[5] Japanese guidelines apply specifically to display systems (whether factory or dealer installed) and include any auditory information provided by the display system.

[6] Alliance principles are not intended to apply to conventional information or communication systems nor to collision warning or vehicle control systems. These principles are not a substitute for regulations and standards that should be respected and used by suppliers and manufacturers of in-vehicle information and communication systems. In the event of any conflict between these principles and applicable regulations, the regulations take precedence.

[7] Guidelines permit systems to be designed to either 2.1A or 2.1B

[8] These aspects of performance are not explicitly detailed in the Alliance guidelines or ECE principles but are captured through reference to ISO 15008

						prescribed
- Size of characters	4.1(2)	None provided	2.2[8]	Design to conform	4.3.3.2[8]	Inspection to referenced standards
- Font dimensions	4.1(2)	None provided	2.2[8]	Design to conform	4.3.3.2[8]	Inspection to referenced standards
- Blinking	4.1(2)	None provided	2.2[8]	Design to conform	4.3.3.2[8]	Inspection to referenced standards
Audibility	4.1(2)	None provided			4.3.3.2	Inspection to referenced standards
Luminous Intensity shall not "Dazzle" driver at night	4.1(3)	None provided				
Timeliness and accuracy of information		None provided	2.3	Design to conform and validate by appropriate means	4.3.3.3	Inspection
Prioritization (between vehicle head unit and tethered mobile device)		None provided			4.3.3.4	Inspection
No uncontrollable sound	4.3(1) 4.3(2)	None provided	2.4	Design to conform and validate by appropriate means	4.3.3.5 4.3.4.6	Inspection
At least one hand on the steering wheel	5(1)	None provided	3.1	Analysis of the system design or through other appropriate means	4.3.4.1	Inspection
Chunk-ability	5(4)	Annex 2			4.3.4.2	Criteria provided for judgement by designers and ergonomics specialists
Interrupt-ability / Resume-ability	5(6)	None provided	3.3	Verify by inspection or demonstration	4.3.4.3	Inspection
Hands-free speech		None provided	3.2	Design to conform and validate by appropriate means		
Driver control of pace	5(8)	None provided	3.4	Design to conform and verify by appropriate means	4.3.4.4	Inspection
Timely feedback	5(9)	None provided	3.5	Demonstrate conformity to the specified system input response through analytical or empirical means	4.3.4.7	Measurement of system response time
Visual Information can be switched off	5.5	None provided	3.6	Verification should be done through inspection of the system, its states, and the dynamic non-safety-related info that it presents	4.3.4.8	Inspection
Distracting information should not be presented to driver (e.g., No TV or scrolling text)	4.1(1)	None provided	4.1	Demonstrate that when the vehicle is in motion, dynamic visual information listed in the criteria, which is not related to driving, is not visible to the driver	4.3.5.1	Inspection
No functional interference					4.3.5.2	Inspection
Locked during driving	4.2(2) 5(7)	Annex 2 (4.2(2)) None Provided (5(7))	4.2	Design to conform and verify by appropriate means	4.3.5.3	Inspection
Malfunction notification			4.3	Design to conform and verify by	4.3.5.4	Inspection

				appropriate means		
Instructions on system usage			5.1	None provided	4.3.6.1 4.3.6.5	Inspection
Instructions on safety should be correct and simple	6(1) 6(2)		5.2	None provided	4.3.6.5	Assessment and judgement
Instructions provide in relevant language (or understandable form)	6(3)		5.3	None provided	4.3.6.3	Assessment & judgement taking into account the system's functionality and intended user groups
Instructions distinguish between driving and non-driving tasks			5.4	None provided	4.3.6.4	Inspection
Information highlight if special skills are necessary or product/feature in unsuitable for particular users			5.5	None provided	4.3.6.6	Inspection
Representations of system should not create unrealistic expectations, nor encourage unsafe or illegal use			5.6	None provided	4.3.6.7	Assessment & judgement taking into account the system's functionality and intended user groups

Reference Guidelines/Standards (not exhaustive)

- **Design Guidelines for Safety of In-Vehicle Information Systems** (2004), Transportation Research Laboratory (TRL), A. Stevens, A. Quimby, A. Board, T. Kersloot and P. Burns.
- **Human Factors Design Guidelines for Advanced Traveler Information Systems (ATIS) and Commercial Vehicle Operations (CVO)** (1997), Developed by Battelle under contract from the U.S. Department of Transportation, Federal Highway, Technical Report FHWA-RD-98-057, J.L. Campbell, C. Carney, B.H. Kantowitz.
- **HARDIE Design Guidelines Handbook: Human Factors Guidelines for Information Presentation by ATT Systems** (1996), Commission of the European Communities, Luxembourg, T. Ross, K. Midtland, M. Fuchs, A. Pauzie, A. Engert, B. Duncan, G. Vaughan, M. Vernet, H. Peters, G. Burnett, A. May.
- **SAE J2364 - Recommended Practice Navigation and Route Guidance Function Accessibility While Driving** (2004), Society of Automotive Engineers (SAE).
- **SAE J2365 – Recommended Practice Calculation of the Time to Complete In-Vehicle Navigation and Route Guidance Tasks** (2002), Society of Automotive Engineers (SAE).
- **A Safety Checklist for the Assessment of In-Vehicle Information Systems: Scoring Proforma** (1999), Transportation Research Laboratory (TRL), Project Report PA3536-A/99, A. Stevens, P.A. Board, A. Quimby.
- **Preliminary Human Factors Guidelines for Driver Information Systems** (1993), The University of Michigan Transportation Research Institute (UMTRI) under contract from the U.S. Department of Transportation, Federal Highway, Technical Report UMTRI-93-21 (also published as FHWA-RD-94-087, P. Green, W. Levinson, G. Paelke, C. Serafin
- **International Organization for Standardization (ISO)**

  ISO 15005 - Road vehicles -- Ergonomic aspects of transport information and control systems -- Dialogue management principles and compliance procedures

  ISO 15006 - Road vehicles -- Ergonomic aspects of transport information and control systems -- Specifications for in-vehicle auditory presentation

  ISO 15007-1 - Road vehicles -- Measurement of driver visual behaviour with respect to transport information and control systems -- Part 1: Definitions and parameters

ISO 15007-2 - Road vehicles -- Measurement of driver visual behaviour with respect to transport information and control systems -- Part 2: Equipment and procedures

ISO 15008 - Road vehicles -- Ergonomic aspects of transport information and control systems -- Specifications and test procedures for in-vehicle visual presentation

ISO TC 16951 - Road vehicles -- Ergonomic aspects of transport information and control systems (TICS) -- Procedures for determining priority of on-board messages presented to drivers

ISO 16673 - Road vehicles -- Ergonomic aspects of transport information and control systems -- Occlusion method to assess visual demand due to the use of in-vehicle systems

ISO 2575 - Road vehicles -- Symbols for controls, indicators and tell-tales

ISO 4040 - Road vehicles -- Location of hand controls, indicators and tell-tales in motor vehicles

ISO 4513 - Road vehicles -- Visibility -- Method for establishment of eyellipses for driver's eye location

ISO 17287 - Road vehicles -- Ergonomic aspects of transport information and control systems -- Procedure for assessing suitability for use while driving

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