MIS005

Creating the future of transport

Checklist for the assessment of in-Vehicle information systems

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Checklist for the assessment of in-vehicle information systems

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Development of a safety checklist for the assessment of in-vehicle information systems

Client: **Department for Transport, International Vehicle Standards**

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Contents

1 Introduction **1**

1.1 Background and Availability 1

1.2 Aims and Use of the Checklist 1

1.3 Recommendations for assessment 2

1.4 Completing the Response Boxes 3

1.5 Assessment summary reports 5

2 Assessment Scenario **7**

3 Checklist Assessment **9**

A Installation 9

B Information Presentation 12

C Interaction with Displays and Controls 18

D System Behaviour 22

E Information about the System 24

4 Assessment Summary Report **27**

5 Supportive Information **29**

A Installation 29

B Information Presentation 35

C Interaction with Displays and Controls 42

D System Behaviour 48

E Information about the System 51

6 Bibliography **57**

Appendix 1 Technical References **59**

Appendix 2 Abbreviations and Glossary **63**

Appendix 3 ESoP (2008) and Checklist Table of Correspondence **65**

Appendix 4 Checklist Feedback Sheet **70**

1 Introduction

This document contains a Checklist for assessing In-Vehicle Information Systems (IVIS) against established ergonomics custom and practice.

- Section 1 (this section) describes the background, availability, and aims of the Checklist and includes recommendations for its use.
- Section 2 provides a proforma for recording the assessment scenario.
- Section 3 contains the Checklist questions and scoring sheet.
- Section 4 provides a number of tools for recording and summarising assessments.
- Section 5 contains Supportive Information which provides additional rationale and clarification of Checklist questions and procedures.

The document also contains a series of Technical References (Appendix 1), Abbreviations and a Glossary of terms (Appendix 2), ESoP and Checklist Table of Correspondence (Appendix 3) and Checklist Feedback Sheets (Appendix 4).

1.1 Background and Availability

A checklist for the assessment of IVIS was developed on behalf of the UK Department for Transport in the late 1990s (Stevens, Board, Allen and Quimby, 1999). This was validated, at least to an extent, during a "consistency workshop" and has since been used in the UK as a post-development assessment tool (Stevens and Board, 2001).

This Checklist has been further developed in response to the intersection of two requirements:

1. Recent experience (and anecdotal evidence) suggested that the Checklist should be updated in response to developments in hardware and interface design.
2. European consensus concerning the principal aspects of safe in-vehicle design has been codified in the European Statement of Principles (ESoP, 2008). With the ESoP having the status of an EC Recommendation, and with HMI regulation being discussed in the ITS Action Plan (ITS Action Plan, 2010), the question arises as to how a specific IVIS should be evaluated for "compliance" with the ESoP; the European eSafety Forum working groups (2008) and emerging eSafety recommendations have identified evaluation using the ESoP as a research requirement.

The new Checklist responds to both of these needs: it is updated in terms of technology and is structured according to the ESoP.

The Checklist is available in hardcopy and as an electronic spreadsheet allowing completion using traditional "pen and paper" method and also by tablet PC or other electronic device. Additional copies of the checklist forms are available from the TRL website. The electronic spreadsheet is available upon request from enquiries@trl.co.uk.

1.2 Aims and Use of the Checklist

The primary aim of the Checklist is to provide a structured approach for assessing the interface design of an IVIS and to identify where further development work or detailed measurements might be required. The Checklist does not evaluate safety *per se*: safe or unsafe use arises from driver behaviour during, and following, interaction with the IVIS. Nevertheless, safe use of an IVIS is promoted by good ergonomic design, and it is the extent to which good design is embodied in the IVIS that is being assessed.

The Checklist is structured as a series of questions that are intended to be answered from simple observation of the IVIS design and operation. The Checklist provides a contribution to assessing an IVIS against the ESoP but does not include detailed

measurement procedures. It does, however, identify where specific quantitative measurements might be required to validate a design approach. In some cases a Principle within the ESoP is represented as a series of questions within the Checklist (a correspondence summary is provided in Appendix 3).

The Checklist also includes some interface and usability issues that are not covered by the 2008 ESoP. In part, this is because the ESoP responds to technology and design evolution and follows a consensus approach in development. The distinction between questions that are in line with the ESoP (2008) and additional questions is made in the table of correspondence in Appendix 3.

The Checklist is intended to be relatively robust to developments in technology and so often uses generic terms for interface components. Whilst fundamental human factors principles are essentially invariant, their application to in-vehicle system design needs interpretation and the generic terms should be interpreted flexibly in the light of technology development. So, for example, "input controls" include all elements of the IVIS interface through which the driver provides control inputs including turn-knobs, buttons, touch-screens, joysticks, pedals, and microphones. Also, "the IVIS" means all components of the IVIS including any wires and fixing components.

The Checklist may be used to assess individual functions, a single screen display or a complete IVIS. It may also be used for systems installed within a vehicle or applied to bench "mock-ups" or simulations. Of course, some judgement has to be made about relevant aspects that can be assessed in such situations.

The Checklist is designed to assess both IVIS which are brought into the vehicle environment (so called "Nomadic Devices") and to benchmark original vehicle equipment.

An active area of in-vehicle HMI development involves integration of information and other systems within the vehicle environment. This can involve shared use of controls and displays as well as communication/prioritisation between (perhaps multiple) IVIS and other vehicle systems. Whilst the Checklist includes some consideration of integration issues, these may not be fully covered.

Users of the Checklist will usually have some knowledge of ergonomics and road vehicle safety issues. The Checklist questions and associated information are intended to promote robust results independent of the assessors' background. Nevertheless, individual judgement may be required in some cases and experience is therefore likely to be beneficial.

Results arising from Checklist assessment may be used in a number of ways including internal design development, benchmarking, marketing and consumer information. Such application is beyond the scope of this document and entirely for the users.

1.3 Recommendations for assessment

The process and context for undertaking an assessment will depend on the objectives of that assessment. In all cases, it is recommended that assessors are familiar with the Supportive Information before using the Checklist. Also, unless the focus of attention is naive use, *it is recommended that assessors familiarise themselves with both the user instructions and operation of the IVIS prior to undertaking an assessment.* This will usually involve using the IVIS whilst driving, to fully appreciate interaction in this context.

A full assessment involves completing three stages:

1. The Assessment Scenario (Section 2)
2. The Response Boxes for the Checklist Assessment (Section 3)
3. An appropriate Assessment Summary Report (Section 4)

The Assessment Scenario captures important information about the IVIS (including product/version, manufacturer and build status), a description of the system components and any documentation available. It also identifies which functions are included in and excluded from assessment and the context of use.

It is recommended that, wherever possible, two people are involved in completing the Checklist Assessment. This allows a measure of cross-checking and consensus and also allows, if required, one to drive and the other to note observations. It is recommended that the IVIS is assessed under a range of conditions (e.g. lighting conditions - typically both daylight and darkness). During any night time observations, the second assessor (if present) should take care not to cause disruption to the interior vehicle illumination.

The following questions require observation in daylight and in darkness and a moon symbol (☽) appears next to these question numbers in the checklist:

- A11, A12
- B2, B3, B4, B5, and B6.

Where an assessment of the whole IVIS in the driving environment is required, the IVIS should be correctly installed, to the manufacturer's specification, in an appropriate vehicle. Such assessments should be carried out from the 'design posture', i.e. the position adopted by the driver following adjustments for reach, field of vision, comfort, etc. Assessors should therefore put on the seatbelt and adjust the seat so that they can reach the foot pedals and steering wheel and can operate them comfortably. It should be possible to see comfortably through the windscreen and into all mirrors. However, assessor(s) should bear in mind the full range of user groups, including drivers who may be at the extremes of the user population, for example, tall, short, physically disabled, aurally impaired or colour blind users.

For consistency, it is recommended that an assessment of a complete IVIS be undertaken on the premise that the driver will comply with the supplier's instructions and guidelines. For example, if the instructions state that certain functions should not be used while the vehicle is in motion, those functions may be excluded from assessment. In any report, however, the assessors may wish to comment on possible, or likely, system misuse by drivers.

The Checklist uses a series of questions and response boxes to allow an assessment of the design solution based on observations of the IVIS and system behaviour. These response boxes are described in Section 1.4.

Within the Supportive Information (Section 5), reference is made to relevant standards, guidelines and/or the European Statement of Principles (ESoP) for each question, which provide assessors with a source of more in-depth information, should this be required. It is recommended that the Supportive Information is read before or in conjunction with the assessment. Assessors may indicate that more sophisticated follow-up objective measurements may be required in some circumstances.

1.4 Completing the Response Boxes

Most questions in the Checklist have the following response boxes. Only one box should be ticked in response to each question.

None		Minor		Serious		N/A	

The box marked 'None' refers to **'No concerns about the design'**, 'Minor' to **'Minor concerns about the design'**, 'Serious' to **'Serious concerns about the design'** and 'NA' to **'Not applicable'**.

In order to decide whether there are concerns, an assessment should be made both of the Human Machine Interaction (HMI) design of the IVIS and the risk to the driver and other road users of interacting with the IVIS, as well as the likely on-road responses of the driver to any information provided.

For a small number of questions, direct observation may be insufficient to determine if the design of the IVIS is in accordance with the ESoP and an additional box is provided to indicate that a Quantitative Measurement (QM) is required.

It is recommended that assessors record their comments and/or reasoning for 'minor' or 'serious' responses at an appropriate place on the checklist, in order to assist any second level assessment, and as an input into the Assessment Summary Report.

No Concerns

None	

This box should be ticked when interaction with the IVIS would not compromise the driver's ability to control the vehicle and operate it safely, for most drivers under most conditions.

This box should also be ticked when the IVIS instructions state that the particular attribute the question is assessing should not be used while the vehicle is in motion.

Minor Concerns

Minor	

This box should be ticked when interacting with the IVIS might, sometimes, compromise vehicle control and operation for some drivers under some conditions.

If any 'minor concerns' boxes are ticked at any point in the assessment, a second level assessment is recommended when completing the final Assessment Summary Form (Section 4) following completion of the in-depth Checklist assessment. This would involve an overall assessment of the number, type and existence of any relationship between the minor concerns. The accumulative effect of several minor concerns might lead the assessor(s) to conclude that the overall system design was inappropriate.

Serious Concerns

Serious	

This box should be ticked when interacting with the IVIS is likely to prevent a significant number of drivers under normal driving conditions, from maintaining full control and safe operation of the vehicle. Problem areas should be detailed in the final summary report.

Not Applicable

N/A	

This box should be ticked when the IVIS does not have the particular attribute the question is addressing.

TRUE / FALSE / N/A

Many of the questions are followed by a short list of statements, which can be used to identify relevant features that will assist in making the final decision for that question. Each of these statements can be answered True, False or Not Applicable. 'True' statements indicate that design is consistent with good ergonomics practice and is therefore less likely to cause problems in operation. 'False' indicates poor or inappropriate design and may identify a potential safety hazard. 'Not applicable' applies when the IVIS does not have a feature relevant to the statement. The assessors must use their own judgement in relating True / False / N/A statements to an overall assessment for the question. The short statements are intended to assist in identifying specific factors, but their relevance and weighting will depend on the IVIS.

Quantitative Measurement Required

QM	

For some Checklist questions, observation and judgement may be deemed insufficient, particularly in "grey areas" where consensus over the issue would be difficult. For example, secure fixing of the IVIS needs to be judged under emergency braking and crash conditions. Also, the simplicity of the information display, and hence the extent to which drivers can assimilate information, may need to be experimentally measured. Assessors may, of course, rely on their judgement or may wish to indicate that a Quantitative Measurement is required. In part, this depends on the ultimate use of the Checklist results.

Whether, and how, quantitative measurements are made on an IVIS is currently outside the scope of the Checklist and Supportive Information.

1.5 Assessment summary reports

Following completion of the Checklist sections (A to E), an Assessment Summary Report should be completed. Different reports will be appropriate depending on the scope and objectives of the assessment and a selection is provided in Section 4. Assessment Summary Reports can be completed for partial software mock-ups, single function assessments with design modification recommendations, or overall IVIS assessments.

The Assessment Summary Report provides an opportunity to note good and poor design features, to comment on any safety concerns, and to identify recommendations.

It is important to recognise the potential benefits that systems may have, in addition to their drawbacks. For example, in the assessment of a navigation system, it is important to recognise that although the system may encourage the driver to direct brief glances away from the road, this may still be preferable to using a conventional map.

If the Checklist software is used to enter assessments, the automated Assessment Summary Report may be used as a first step in summarising results.

The overall final report on the system is outside the scope of the Checklist, but it is likely that the Checklist assessment will provide an important input. The report should detail any additional assessments (other than the Checklist) that were carried out, including, for example, comments concerning any reasonably foreseeable misuse, which may present safety concerns. If any major safety concerns are raised as a result of the Checklist assessment, the assessors may make the recommendation that the system not be used until certain features are redesigned. This recommendation may also be appropriate if there are numerous minor safety concerns identified. Recommendations for redesign and usage should be made wherever possible.

2 Assessment Scenario

1. IVIS under assessment

Product name and version	
Manufacturer/Supplier	
Build Status (e.g. prototype, production)	
Description of HMI Subsystems (e.g. screen, hand control)	
Documentation included (e.g. driver's manual)	

2. IVIS functions included in/excluded from assessment

Functions Included

OR:

Functions Excluded	**Reason for exclusion** (e.g. not intended for use while driving)

3. Context and restrictions for Checklist assessment

Vehicle Make and Model	
Driver group considered (e.g. special skill requirements)	
Context of IVIS use (e.g. in a vehicle while driving, concurrent use with other IVIS)	
Road type considered (e.g. urban, motorway)	
Traffic (e.g. mix and density)	
Other environmental (e.g. weather, day/night time)	
External data feeds required (e.g. GPS, RDS-TMC)	

Assessors:
Date:

Before completing the Checklist Assessment and Assessment Summary Report, please familiarise yourself with the information provided in the Introduction.

3 Checklist Assessment

A Installation

A1 Is the IVIS fitted in accordance with the manufacturer's instructions for installing the system in vehicles?

None		Minor		Serious		N/A	

A2 Is the IVIS securely fitted?

None		Minor		Serious		N/A		QM	

A3 Once positioned and secured are the relevant components of the IVIS stable?

None		Minor		Serious		N/A	

A4 Once positioned and secured are the relevant components of the IVIS free from shake?

None		Minor		Serious		N/A	

A5 Are the IVIS controls easily reached by the user when driving?

All controls needed when driving can be reached from the normal driving position.	TRUE/FALSE/N/A
Stretching or leaning is not required.	TRUE/FALSE/N/A
Awkward arm or body positions are not required.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

A6 Is physical and visual access to the IVIS free from obstruction by other driver controls/displays?

No IVIS displays are obstructed.	TRUE/FALSE/N/A
No IVIS controls are obstructed.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

A7 Is the driver's view of the road scene free from obstruction by the IVIS?

The swept windscreen area is fully clear.	TRUE/FALSE/N/A
The view of the mirrors is not restricted.	TRUE/FALSE/N/A
The side windows are fully clear.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

A8 Is physical and visual access to primary driver controls free from obstruction by the IVIS and its mounting?

The IVIS does not interfere with normal leg, hand and arm movements.	TRUE/FALSE/N/A
The IVIS does not interfere with use of the accelerator, brake or clutch.	TRUE/FALSE/N/A
The IVIS does not interfere with the use of the steering wheel.	TRUE/FALSE/N/A
The IVIS does not interfere with the direction indicators or windscreen wipers.	TRUE/FALSE/N/A
The IVIS does not interfere with the use of the lights.	TRUE/FALSE/N/A
The IVIS does not interfere with the use of the horn.	TRUE/FALSE/N/A
The IVIS does not interfere with use of the gear lever.	TRUE/FALSE/N/A
The IVIS does not interfere with use of the parking brake.	TRUE/FALSE/N/A
The IVIS does not interfere with the use of the hazard warning lights.	TRUE/FALSE/N/A
The IVIS does not interfere with the use of the de-mister controls.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

A9 Is physical and visual access to primary driver displays free from obstruction by the IVIS and its mounting?

The IVIS does not obscure the display of speed.	TRUE/FALSE/N/A
The IVIS does not obscure the telltale display of the indicators.	TRUE/FALSE/N/A
The IVIS does not obscure safety warnings.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

A10 Is the IVIS visual display positioned close to the driver's normal line of sight?

None		Minor		Serious		N/A		QM	

◗ A11 Is the IVIS free from reflections and glare under all ambient lighting conditions?

A manual/automatic switch between day and night modes is provided.	TRUE/FALSE/N/A
The IVIS is free from reflection/glare:	
during the day.	TRUE/FALSE/N/A
during darkness.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

◗ A12 Are the windscreen and windows free from reflections and/or glare caused by the display?

The windscreen and windows are free from reflection/glare:	
during the day.	TRUE/FALSE/N/A
during darkness.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

B Information Presentation

B1 Are messages presented visually simple?

The IVIS avoids the use of long messages.	TRUE/FALSE/N/A
Each message is distinct from others.	TRUE/FALSE/N/A
The meaning of the message is clear.	TRUE/FALSE/N/A
Information presented by visual and other modalities is consistent.	TRUE/FALSE/N/A

None		Minor		Serious		N/A		QM	

B2 Is each control easily discernible by different methods in daylight and during darkness?

The IVIS controls can be distinguished as follows:

Vision:	- by labels/graphics/representational features.	TRUE/FALSE/N/A
	- by colour.	TRUE/FALSE/N/A
	- by shape.	TRUE/FALSE/N/A
	- by brightness.	TRUE/FALSE/N/A
Touch:	- by means of clearance.	TRUE/FALSE/N/A
	- by means of location.	TRUE/FALSE/N/A
	- by means of grouping.	TRUE/FALSE/N/A
	- by means of shape.	TRUE/FALSE/N/A
	- by means of texture.	TRUE/FALSE/N/A
	- by motion feedback.	TRUE/FALSE/N/A
Hearing:	- by auditory feedback.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

B3 Is colour used effectively to aid coding and layout of controls?

Red/green combinations are avoided.	TRUE/FALSE/N/A
Blue/yellow combinations are avoided.	TRUE/FALSE/N/A
Colour coding does not cause problems during darkness.	TRUE/FALSE/N/A
Colours used do not cause adverse visual after effects.	TRUE/FALSE/N/A
The meaning of colour coding is clear.	TRUE/FALSE/N/A
Colour coding conforms to stereotypical norms in the expected country/area of use.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

B4 Are colours used effectively in the design and presentation of visual images?

Colours are limited to clearly differentiated sets.	TRUE/FALSE/N/A
Colours are equally visible under night-time viewing conditions.	TRUE/FALSE/N/A
Red/green and blue/yellow colour combinations are avoided.	TRUE/FALSE/N/A
Colour displays (LED and display images) are unambiguous without full colour vision.	TRUE/FALSE/N/A
Problems of colours distorting the appearance of adjacent colours and colour after-effects are avoided.	TRUE/FALSE/N/A
Colours conform with stereotypical norms.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

B5 Are the displays lit during darkness without unduly affecting vision?

The IVIS illumination does not distract the driver.	TRUE/FALSE/N/A
The IVIS illumination does not cause visual discomfort.	TRUE/FALSE/N/A
The IVIS illumination does not prevent the displayed information from being clearly legible.	TRUE/FALSE/N/A
The IVIS illumination does not cause visual after effects.	TRUE/FALSE/N/A
Automatic/manual dimming controls are within an acceptable range.	TRUE/FALSE/N/A
The IVIS internal illumination can be used without washout of the display in any conditions.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

B6 Does the lighting of controls during darkness affect vision?

Control lighting is adequate to identify the required control.	TRUE/FALSE/N/A
Control lighting is not so bright as to distract the driver.	TRUE/FALSE/N/A
Control lighting is not so bright as to cause visual discomfort or visual after effects.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

B7 Is the auditory message appropriate for the information to be conveyed?

The message is short.	TRUE/FALSE/N/A
The message is simple.	TRUE/FALSE/N/A
The message does not need to be referred to later.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

B8 Is information presented by speech clearly audible?

Speech is not distorted.	TRUE/FALSE/N/A
Speech is clear.	TRUE/FALSE/N/A
Speech is at an appropriate frequency/pitch.	TRUE/FALSE/N/A
The language and dialect are suitable for the user population.	TRUE/FALSE/N/A
The language is user-selectable.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

B9 Is the layout of graphics/representational features appropriate?

The choice of graphics/representational features is suitable for what they represent.	TRUE/FALSE/N/A
The design of graphics/representational features is not too detailed or complex.	TRUE/FALSE/N/A
Functionally related graphics/representational features have a consistent style.	TRUE/FALSE/N/A
The use of text can be supported by graphics/representational features.	TRUE/FALSE/N/A
The use of graphics/representational features can be supported by text.	TRUE/FALSE/N/A
Graphics/representational features representing road signs are the same as actual road signs.	TRUE/FALSE/N/A
The apparent size of the display images is appropriate to their function.	TRUE/FALSE/N/A
Graphics/representational features are functionally grouped where possible.	TRUE/FALSE/N/A
Graphics/representational features are not cluttered.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

B10 Is numerical data presented appropriately?

An analogue format is used for fluctuating values.	TRUE/FALSE/N/A
An appropriate number of decimal places are used.	TRUE/FALSE/N/A
Numbering has appropriate units where required.	TRUE/FALSE/N/A
A digital display is employed for relatively steady values where the absolute numerical value needs to be known.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

B11 Is the choice of words appropriate?

Short words are used in preference to long ones.	TRUE/FALSE/N/A
The words used in the dialogue are simple and obvious.	TRUE/FALSE/N/A
The IVIS avoids the use of jargon when 'plain language' could be used.	TRUE/FALSE/N/A
The order of wording is logical and grammatically correct.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

B12 Are abbreviations used appropriately?

Abbreviations used aid the readability of the messages.	TRUE/FALSE/N/A
Abbreviations are used consistently.	TRUE/FALSE/N/A
Abbreviations conform to standard conventions.	TRUE/FALSE/N/A
Entire sentences are never made up from abbreviations.	TRUE/FALSE/N/A
Abbreviations are translated correctly for the country and language of their use.	TRUE/FALSE/N/A
Abbreviations are an appropriate method of conveying this information.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

B13 Is the driving-relevant information correct?

Messages contain all necessary information.	TRUE/FALSE/N/A
Information is consistent with:	
the legal status of the road system.	TRUE/FALSE/N/A
external information on road signs.	TRUE/FALSE/N/A
external information on VMS displays.	TRUE/FALSE/N/A
external information on RDS broadcasts.	TRUE/FALSE/N/A
other external information.	TRUE/FALSE/N/A
other internal information.	TRUE/FALSE/N/A
The system provides timely updated advice after non-compliance with instructions.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

B14 Is a suitable indication given when new/updated information arrives that is directly relevant to the driver in the current driving situation?

The method of indicating new information arriving is effective.	TRUE/FALSE/N/A
The method of indicating new information does not startle the driver.	TRUE/FALSE/N/A
The method of indicating new information is appropriate to the message being conveyed.	TRUE/FALSE/N/A
The information is up to date and relevant to the current, real-time situation.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

B15 Is information of higher safety relevance given higher priority?

None		Minor		Serious		N/A	

B16 Where the volume of auditory output cannot be adjusted, does it present any concerns?

Auditory output is loud enough to be heard under all driving conditions.	TRUE/FALSE/N/A
Auditory output is not so loud that it may mask audible warnings from within the vehicle.	TRUE/FALSE/N/A
Auditory output is not so loud that it may mask audible warnings from outside the vehicle.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

B17 Is the use of Head Up Displays (HUDs) appropriate?

The information is appropriate for a HUD.	TRUE/FALSE/N/A
HUDs do not mask any important information.	TRUE/FALSE/N/A
HUDs do not cause any reflections on interior surfaces.	TRUE/FALSE/N/A
HUDs do not distract the driver.	TRUE/FALSE/N/A
HUDs are free from the effects of glare.	TRUE/FALSE/N/A
HUDs have an appropriate brightness and contrast.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

B18 Does presentation of information by the IVIS in combination with other vehicle systems cause conflicts?

When a visual display is shared between IVIS functions, conflicts will not arise between them.	TRUE/FALSE/N/A
When an auditory message is presented, other auditory outputs (eg the radio) will mute.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

C Interaction with Displays and Controls

C1 Is the driver able to keep at least one hand on the steering wheel while interacting with the IVIS?

None		Minor		Serious		N/A	

C2 Is it easy to navigate through the IVIS menus?

There are an appropriate number of menus, sub-menus and final options.	TRUE/FALSE/N/A
The user can move from menu to sub-menu easily.	TRUE/FALSE/N/A
The user can move back through sub-menus easily.	TRUE/FALSE/N/A
The users are allowed to move backward and correct mistakes.	TRUE/FALSE/N/A
There is a cancel or escape button provided in the menu.	TRUE/FALSE/N/A
The user is not trapped deep within the menu structure.	TRUE/FALSE/N/A
Menu labels are easy to understand.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

C3 Is the manual-visual interaction short or interruptible?

The interaction requires 3 inputs or less.	TRUE/FALSE/N/A
If the interaction takes more than 3 inputs, the sequence is interruptible.	TRUE/FALSE/N/A
The IVIS does not make choices for the user even if there is an input delay.	TRUE/FALSE/N/A
The driver can defer responding to the IVIS without loss of system status.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

C4 Is the driver able to resume an interrupted dialogue with the IVIS at the point of interruption or at another logical point?

None		Minor		Serious		N/A	

C5 Is the IVIS free from "machine pacing"?

The speed at which the IVIS presents and replaces information is appropriate. TRUE/FALSE/N/A

Information is presented sufficiently in advance of a driving decision. TRUE/FALSE/N/A

The auditory information is automatically repeated when appropriate. TRUE/FALSE/N/A

The auditory information can be repeated on request by the user. TRUE/FALSE/N/A

None		Minor		Serious		N/A	

C6 Is the IVIS control layout suitable for safe operation?

Each control can be used without inadvertently activating another control. TRUE/FALSE/N/A

The layout of the controls is conducive to them being located non-visually. TRUE/FALSE/N/A

If integrated controls are used, they are used appropriately. TRUE/FALSE/N/A

None		Minor		Serious		N/A	

C7 Is the volume of auditory output adjustable over a reasonable range?

Auditory output can be adjusted to:

be heard under all driving conditions. TRUE/FALSE/N/A

a level that will not startle the driver. TRUE/FALSE/N/A

None		Minor		Serious		N/A	

C8 Is immediate feedback provided when an input error is made?

The user can see/hear immediately if they have made an input error or incompatible choice. TRUE/FALSE/N/A

The system provides timely updated advice after non-compliance with instructions. TRUE/FALSE/N/A

None		Minor		Serious		N/A	

C9 Is control activation feedback adequate and appropriate?

Control activation is indicated by:	
displacement feedback.	TRUE/FALSE/N/A
visual feedback.	TRUE/FALSE/N/A
auditory feedback.	TRUE/FALSE/N/A
The user can see/hear immediately that the IVIS is responding to their input.	TRUE/FALSE/N/A
The IVIS can cope with fast sequential data input.	TRUE/FALSE/N/A
Visual feedback persists long enough to permit vision to the road to be maintained and the feedback not be lost.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

C10 Following control activation feedback, is the required information provided within an appropriate timescale?

The IVIS informs the user that it is "busy".	TRUE/FALSE/N/A
User frustration from slow response is unlikely.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

C11 Can dynamic non-safety related information be deselected?

The user is able to turn off non-safety related information.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

C12 Is the design of the IVIS controls suitable for their function?

Controls do not perform more than two functions.	TRUE/FALSE/N/A
Where a control has two actions, they cannot be easily confused.	TRUE/FALSE/N/A
Where a control has two actions, they do not need to be carried out simultaneously.	TRUE/FALSE/N/A
Rotary knobs/multi-rotational knobs/thumb wheels etc. are only used to transmit continuous information.	TRUE/FALSE/N/A
Control actions are consistent with conventions adopted:	
in the rest of the vehicle.	TRUE/FALSE/N/A
in the national location where the IVIS is to be used.	TRUE/FALSE/N/A
Control labels are consistent with conventions adopted:	
in the rest of the vehicle.	TRUE/FALSE/N/A
national location where the IVIS is to be used.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

C13 Is the use of non-contact input controls (e.g. speech) appropriate for their function?

Non-contact input controls do not require time critical responses.	TRUE/FALSE/N/A
Long speech input is not required.	TRUE/FALSE/N/A
Speech recognition can be turned off and another method of input is provided.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

C14 Are touchscreens easy to use?

The size of the 'active' areas is sufficient.	TRUE/FALSE/N/A
There is sufficient separation space between 'active' areas.	TRUE/FALSE/N/A
Input feedback is adequate.	TRUE/FALSE/N/A
The sensitivity of the active areas is appropriate.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

D System Behaviour

D1 Does the IVIS display distracting images unrelated to driving?

The IVIS limits visual information available when the vehicle is moving.	TRUE/FALSE/N/A
Visual information does not have a dynamic component.	TRUE/FALSE/N/A
All dynamic visual images relate closely to driving.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

D2 Does the behaviour of the IVIS adversely interfere with displays or controls required for the primary driving task and for road safety?

The IVIS does not override information that is required for safe driving.	TRUE/FALSE/N/A
The IVIS does not obstruct other safety systems.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

D3 Are system functions that are not intended to be used by the driver when driving impossible to interact with when the vehicle is in motion?

None		Minor		Serious		N/A	

D4 Does the supplier make it sufficiently clear that the driver retains absolute responsibility for the operation of the vehicle and compliance with traffic regulations regardless of information provided by the IVIS?

The user instructions clearly state that the driver retains overall responsibility for vehicle operation.	TRUE/FALSE/N/A
The user instructions clearly state that the driver retains responsibility for complying with traffic regulations.	TRUE/FALSE/N/A
The IVIS itself displays clear responsibility messages.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

D5 Is information presented to the driver about current status and any malfunction within the IVIS?

The user is informed when the auditory output has been turned off.	TRUE/FALSE/N/A
The user is informed when the IVIS malfunctions.	TRUE/FALSE/N/A
The user is informed when there is a loss of external information.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

E Information about the System

E1 Does information available to the driver include clear recommendations for installation of the IVIS?

None		Minor		Serious		N/A	

E2 Does the information available to the driver include adequate instructions for use and maintenance?

There is a user manual.	TRUE/FALSE/N/A
The IVIS displays help information.	TRUE/FALSE/N/A
The consequence of non-compliance with instructions is clearly stated.	TRUE/FALSE/N/A
Maintenance procedures for the equipment are clearly prescribed.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

E3 Are the IVIS instructions correct and simple?

None		Minor		Serious		N/A	

E4 Are IVIS instructions in languages or forms designed to be understood by the intended group of drivers?

None		Minor		Serious		N/A	

E5 Do instructions provide sufficiently clear recommendations for non-use of any of the IVIS functions whilst driving?

User is advised not to access help function while the vehicle is in motion.	TRUE/FALSE/N/A
User is advised not to configure IVIS features when the vehicle is in motion.	TRUE/FALSE/N/A
User is advised not to use any free-standing equipment when the vehicle is in motion.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

E6 Does the product information accurately convey the IVIS functionality?

Product information is correct.	TRUE/FALSE/N/A
Product information distinguishes between functions which are intended to be used while driving and those which are not.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

E7 Does the product information make it clear if special skills are required to use the IVIS as intended by the manufacturer?

User is advised if special skills are required to use the IVIS.	TRUE/FALSE/N/A
User is advised if the IVIS is not suitable for particular users.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

E8 Are unrealistic expectations and encouragement of unsafe use avoided?

The packaging does not promote inappropriate use of the IVIS.	TRUE/FALSE/N/A

None		Minor		Serious		N/A	

4 Assessment Summary Report

Date:

Assessor(s):

Device being assessed:

Context:
- ☐ Static assessment
- ☐ Assessment while driving

Build Status:
- ☐ Partial software mock-up
- ☐ Single function assessment
- ☐ Overall IVIS assessment
- ☐ Other

SUMMARY OF CHECKLIST ASSESSMENT

Serious Concerns and Reasons (refer to specific questions if necessary)

Minor Concerns and Reasons (refer to specific questions if necessary)

Overall Assessment

(Continue over page if necessary)

ADDITIONAL COMMENTS AND DESIGN RECOMMENDATIONS

Additional Comments

Recommendations

(Continue over page if necessary)

5 Supportive Information

This Supportive Information accompanies the Safety Checklist developed for evaluating In-Vehicle Information Systems (IVIS). The Supportive Information is designed to assist assessors when using the Checklist by enabling them to further clarify Checklist questions and understand the rationale behind them. It aims to help assessors identify areas indicative of both good and bad ergonomic design.

This section provides background information and guidance for each question contained within the checklist. It refers to the European Statement of Principles (ESoP), International Standards, Statement of Principles and Regulations (see Technical References, Appendix 1). All Standards are subject to revision. Their most recent edition should be used.

A Installation

A1 Is the IVIS fitted in accordance with the manufacturer's instructions for installing the system in vehicles?

Instructions provided by the product-responsible organisation should be followed with respect to the location and fitting of the equipment.

This is particularly important for after-market systems and nomadic devices. Special attention should be given to the installation of systems in terms of passive safety in order to avoid an increased risk of injury in case of a vehicle crash.

References:

ESoP (2008).

A2 Is the IVIS securely fitted?

Secure fitting requires that IVIS components do not become a safety hazard in normal use or during extreme manoeuvres and crash situations.

The IVIS can be located within the vehicle in the following ways:

- Fixed within the vehicle,
- Moveable over a pre-determined range (e.g. for systems that have an adjustable position by means of cable, stalk or bracket), or
- Holder mounted with the intention that the IVIS is used within the holder.

Secure fitting is particularly important for after-market systems and nomadic devices.

Quantitative measurement may be required to determine security during extreme manoeuvres and near-crash situations.

References:

ESoP (2008).

A3 Once positioned and secured are the relevant components of the IVIS stable?

The IVIS should be installed in such a way that it is stable and such that the driver does not need to frequently adjust its position. The IVIS should be assessed while driving over rough road surfaces, and also at motorway speeds.

References:

ESoP (2008).

A4 Once positioned and secured are the relevant components of the IVIS free from shake?

The IVIS should be installed in such a way that it is free from shake. Shake reduces the legibility of the display and increases the likelihood of manual input errors, thus increasing driver workload and visual distraction. The IVIS should be assessed while driving over rough road surfaces, and also at motorway speeds.

References:

ESoP (2008).

A5 Are the IVIS controls easily reached by the user when driving?

IVIS controls should be designed such that they can be operated without adverse impact on the primary driving task. In particular drivers should be able to reach controls easily without having to stretch from their driving position, since this could increase driver workload and/or visual distraction.

The minimum requirement is that IVIS use is fully compatible with the primary driving task. In this regard, the usability of controls is one of the most important factors.

IVIS controls are all elements of the system interface through which the driver provides control inputs. These include turn-knobs, buttons, touch-screens, joysticks, pedals, and microphones (which is a voice-input control). Badly designed controls have an adverse impact on the driving task as they reduce the driver's ability to control the vehicle.

Assessors should account for a range of driver heights and seat positions.

Examples:

Good: The most frequently used controls are located within fingertip reach of the steering wheel.

Bad: The controls are located beyond the driver's arm length, requiring stretching and leaning to utilise them.

References:

ISO 3958, ISO 4040.

SAE J 1138, SAE J 287.

A6 Is physical and visual access to the IVIS free from obstruction by other driver controls/displays?

The driver's ability to use the IVIS displays and controls should not be compromised by the physical presence of driver controls or by the operation or use of driver controls.

Obstruction of controls, means to prevent operation, or render significantly more difficult to identify, reach and/or operate the relevant controls throughout their intended range of movement. Obstruction of displays occurs when any portion of a display is rendered not visible when viewed from the driver's normal seating position. For example, a display may be obstructed by one of the steering wheel spokes in some positions of the wheel. The assessors are advised to take a view on the seriousness of this temporary obstruction to overall safety.

Assessors should account for a range of driver heights and seat positions.

References:

ESoP (2008).

A7 Is the driver's view of the road scene free from obstruction by the IVIS?

This question is especially important for aftermarket systems and nomadic devices. It does not apply to head-up displays.

Successful performance of the driving task is mainly based on the acquisition of visual information about the local road and traffic environment. Consequently, construction regulations ensure that each road vehicle provides the driver with an adequate external field of view out of the vehicle from the driver's seat. Additional systems must not compromise this basic design provision. This principle is likely to be particularly important for the installation of aftermarket and nomadic systems.

Additionally, no part of the IVIS should obstruct the driver's view of the road scene. The driver's view is that mandatory minimum requirement in accordance with EEC Regulations. It should be interpreted as pertaining to the forward view directly through the windscreen, side views and rear view either directly or indirectly.

When installed in a vehicle, no part of the IVIS should be in a physical position causing the driver's view of the road scene to be obstructed to such an extent that the regulations cannot be complied with.

If the physical position of a component of the IVIS can be modified by the driver and can (as part of its intended range of movement) obstruct the driver's vision, then the driver should be informed through the IVIS instructions about the use as intended by the manufacturer. If no such information is provided to the driver, then the principle should apply throughout the range of adjustment of the IVIS or its component.

Examples:

Good: A display mounted within the instrument panel in such a way that it can be easily viewed by the driver but does not interfere with the field-of-view requirements.

Bad: A display mounted on a long flexible stalk from the upper surface of the instrument panel which can be adjusted in such a way that the display obscures a substantial part of the external road scene.

References:

UNECE Regulation 46.

UNECE Regulation 125.

A8 Is physical and visual access to primary driver controls free from obstruction by the IVIS and its mounting?

The driver's ability to use primary controls and other controls required for safe driving and full control of the vehicle, should not be compromised by the physical presence of the IVIS (including its mounting and wires), or by the operation or use of the IVIS.

Obstruction of controls means prevention of operation, or rendering significantly more difficult to identify, reach and/or operate the relevant controls throughout their intended range of movement.

Primary controls include the accelerator, brake, clutch if fitted, steering wheel, gear lever, parking brake, horn, light switches, turn indicators, windscreen washers and wipers (all modes and speeds), hazard flashers and demister controls.

Assessors should account for a range of driver heights and seat positions.

Examples:

Good: An auditory congestion warning system that does not obstruct and which has no connection with other controls. The device has a simple on/off control that can be easily used without affecting any other controls.

Bad: An after-market route guidance system which obstructs the light switches.

References:

ISO 4513.

A9 Is physical and visual access to primary driver displays free from obstruction by the IVIS and its mounting?

The driver's ability to use primary displays and other displays required for safe driving and full control of the vehicle, should not be compromised by the physical presence of the IVIS (including its mounting and wires), or by the operation or use of the IVIS.

Obstruction of displays means to render not visible some portion (any portion) of the relevant displays from the drivers' normal seating position.

Primary displays include the speedometer, all warning lights, mandatory control labels and mandatory tell-tales.

Assessors should account for a range of driver heights and seat positions.

Examples:

Good: An auditory congestion warning system that does not obstruct and which has no connection with other controls. The device has a simple on/off control that can be easily used without affecting any other displays.

Bad: An after-market route guidance system which obstructs mandatory control labels.

References:

ISO 4513.

A10 Is the visual display positioned close to the driver's normal line of sight?

For a driver to be in full control of the vehicle and aware of the dynamic road scene there is a broad consensus that, apart from brief glances at mirrors or instrumentation, the driver's gaze should be directed towards the road scene. Visual displays positioned close to the normal line of sight reduce the total eyes-off-the-road time relative to those which are positioned further away, thus maximising the possibility for a driver to use peripheral vision to monitor the road scene for major developments while looking at a display. The further away from the driver's normal line of sight the display is positioned, the more difficult it is to obtain information and the greater the possible impact on driving performance.

It is recommended that the most important or safety-critical information be closest to the normal line of sight which therefore requires the designer/installer to make an explicit, but essentially qualitative, trade-off between practicability and closeness. Important factors include:

- The requirement not to obstruct the road scene
- The requirement not to obstruct other controls or displays
- The requirement that the display should not itself be substantially obstructed by, for example, controls such as the steering wheel or gear change lever
- Minimising the amount that the driver has to turn their head
- In particular for passenger cars[1], it is recommended that displays containing information relevant to driving and all displays requiring long sequences of interaction be placed within approximately 30° downward viewing angle of the driver's normal forward view. Quantitative measurements may need to be made if it is not immediately obvious whether the displays are placed within 30° downward viewing angle.

Examples:

Good: A display for navigation in a passenger car is installed within approximately 30° downward viewing angle because the information is related to driving.

Bad: A display for communication, e.g. of a Personal Digital Assistant (PDA) or Phone, is positioned near the gear lever between the front seats in a passenger car in spite of long sequences of interactions necessary to enter or search for a telephone number.

References:

ISO 4513.

SAE J 1050.

A11 Is the IVIS free from reflections and glare under all ambient lighting conditions?

Glare is the distracting (and potentially disabling) effect of bright light in an otherwise relatively dark scene that interferes with visual attention and selection. In the in-vehicle context, this can occur in a number of ways:

[1] Passenger cars are all type M1 vehicles as defined in Directive 70/156/EEC

- External light (usually sunlight) falls on the visual display reducing display contrast and makes the information on the screen more difficult to see from the driver's normal viewing position.
- The display is itself too bright and causes distraction from the road scene and other in-vehicle displays and controls. This is most likely to be apparent to the driver in low ambient light conditions.

Reflection is the generation of a secondary image of an object as a result of light from the object bouncing off intermediate surfaces, e.g. light from an external source (such as the sun, streetlights, or other bright objects) is reflected by the display surface into the driver's eyes (see also glare, above).

Glare and reflections from or on an IVIS are likely to make it more difficult to extract information from the display, and may also cause distraction from the driving task or other tasks that are performed while driving. Sudden reflections may startle the driver. This is likely to lead to increased driver frustration and may evoke behavioural adaptations such as squinting, closing of the eyes for brief periods and exaggerated head movements to obtain a more comfortable view. All of these effects are likely to reduce driver comfort and may compromise road safety to some extent.

All internal and external sources of light should be considered for a range of seat and eye height positions. Assessments should be carried out during the day and after dark. Assessors should bear in mind the effects of street lighting, strong sunlight, vehicle headlights, and reflections off the passenger or passenger seat.

Examples:

Good: A display which has been designed and installed with thought: a screen with an automatic brightness control recessed within the dashboard in a high central position and which has a display front surface which can be easily read under all normal lighting conditions.

Bad: A display whose design and installation does not sufficiently take account of potential glare and reflection problems: A display which is so bright at night that it is significant in the driver's peripheral vision when looking at the forward road-scene and whose information is difficult to read in sunlight because the contrast is so low.

References:

ISO 15008.

☽ A12 Are the windscreen and windows free from reflections and/or glare caused by the display?

Glare is the distracting (and potentially disabling) effect of bright light in an otherwise relatively dark scene that interferes with visual attention and selection.

Reflection is the generation of a secondary image of an object as a result of light from the object bouncing off intermediate surfaces. For example, light from a light emitting display travels to another surface (or via several surfaces) producing a secondary image of the display screen for example, on the windscreen. This is most likely to be perceived by the driver when there is high contrast between the secondary image and its background, such as against the windscreen during darkness.

Reflections and glare from the IVIS onto windows and/or the windscreen must be avoided as they may reduce visibility out of the vehicle, which could increase driver workload and visual distraction, while sudden reflections may startle the driver. Assessments should be carried out during the day and after dark for a range of seat and eye height positions.

Examples:

Good: A screen which does not produce secondary images on the vehicle's glass.

Bad: A display that is so bright that it produces secondary images on the vehicle's glass.

References:

ESoP (2008).

B Information Presentation

B1 Are messages presented visually simple?

Visual processing by the driver to take account of the traffic environment forms the basis for completion of vehicle control and manoeuvring tasks. Therefore, demand to detect and acquire visually presented relevant information at any one time should be limited. Increasing the frequency and/or duration of glances required to detect and acquire visually displayed information may increase the risk for potentially dangerous traffic situations caused by driver preoccupation with non-primary driving-related tasks.

The vocabulary used for messages should be simple and easy to understand by the intended user population, to avoid the driver becoming confused and making errors that could compromise safety. The message should contain information that is sufficiently correct and have the degree of precision for the driver to deal adequately with the situation. Plain language should be used instead of jargon.

If quantitative measurement (QM) is required to answer this question, the number and duration of glances needed to detect and acquire relevant information presented should be measured.

References:

ISO 15007-1, ISO 15007-2.

☽ B2 Is each control easily discernible by different methods in daylight and during darkness?

IVIS controls should be designed such that they can be operated without adverse impact on the primary driving task.

Adverse impact occurs when badly designed controls induce negative consequences on the ability of the driver to undertake correctly the primary driving task. Poor control design may involve their location, shape, and layout.

Good design enables drivers to distinguish controls by several different methods, in order to avoid confusion and aid speedy identification, for example visually by shape, colour or label, or through touch by shape, location, texture, etc.

References:

ESoP (2008).

Leiser (1991).

B3 Is colour used effectively to aid coding and layout of controls?

IVIS controls should be designed such that they can be operated without adverse impact on the primary driving task.

Adverse impact occurs when badly designed controls induce negative consequences on the ability of the driver to undertake correctly the primary driving task. Poor control design may involve the colour of their labels.

The use of colour should assist the driver to identify controls. A small number of colours (no more than five) should therefore be chosen which are not similar in hue, and which will be easily distinguishable in a variety of ambient lighting environments. Red/green and blue/yellow colour combinations should be avoided.

References:

ESoP (2008).

BS 5499-5.

B4 Are colours used effectively in the design and presentation of visual images?

The use of colour should aid understanding, however should ideally be redundant, i.e. the driver should be able to understand visual images without relying solely on colour. Colour will therefore be unlikely to present a serious safety concern, unless it is likely to cause confusion over safety related information. No more than five colours should be used and they should conform to conventions and stereotypes. Red/green and blue/yellow colour combinations should be avoided, as should shades that are very similar.

References:

ESoP (2008).

DIN EN 842.

ISO 15008.

B5 Are the displays lit during darkness without unduly affecting vision?

IVIS displays should be visible during darkness, but the screen should not be so bright that it is distracting or causes visual after effects.

Washout occurs when the internal illumination is altered such that the contrast between information on the display and its background reduces sufficiently to compromise legibility.

Washout should not be possible at night, in bright sunlight, or even if the contrast is altered accidentally, as this may lead to an increase in visual distraction. It should be possible to read the display under all lighting conditions, and assessors should account for a range of seat and eye height positions. Assessors should check that colour and detail can be recognised at different levels of contrast.

References:

ESoP (2008).

Defence Standard 00-250.

ISO 15008.

B6 Does the lighting of controls during darkness affect vision?

If controls are lit during darkness to aid operation, control lighting should be adequate to identify the required control, but should not be so bright as to distract the driver or cause visual after effects.

B7 Is the auditory message appropriate for the information to be conveyed?

The auditory presentation of information is best used when a driver's attention needs to be gained, when the message is short and simple and does not need to be referred to later.

B8 Is information presented by speech clearly audible?

The source of speech information can be human or machine generated. To ensure that the message is clearly audible so that the user does not become confused, the intelligibility of a message should be maximised. Speech is most highly intelligible for sentences rather than isolated words as without the context of the sentence, individual words may not be recognised.

References:

Sanders, M.S. and McCormick, E.J. (1992). *Human Factors in Engineering and Design*. McGraw-Hill, Inc.: New York.

B9 Is the layout of graphics/representational features appropriate?

Graphics should use accepted representations that are likely to be understood by the majority of the user population so as to minimise visual interaction time. The resolution of graphic images should not be affected by colour, flashing graphics or reversing out.

Where available, internationally and/or nationally agreed standards related to icons, symbols, words, acronyms or abbreviations should be used, for example, ISO 2575 - Road Vehicles - Symbols for Controls, Indications and Telltales.

Standards related to symbols prescribe physical and/or geometrical characteristics for information which is displayed visually and are intended to give information the highest probability of being easily read by the population in a large range of circumstances and environments.

References:

ESoP (2008).

ISO 2575, ISO 7000, ISO 7001, ISO 80416-4.

B10 Is numerical data presented appropriately?

Numerical data should use internationally accepted units and provide an appropriate level of precision.

References:

ESoP (2008).

DIN 43802-2.

DIN 43802-3.

DIN 43802-4.

B11 Is the choice of words appropriate?

The continuously increasing number of functions available to the driver makes it necessary to adopt the most common practise in the selection of words for function identification.

References:

ESoP (2008).

B12 Are abbreviations used appropriately?

Abbreviations should be widely known, have clear meaning, be used consistently and conform to local (country) conventions. Abbreviations should not be overused but should only be used where necessary to save space and decrease reading time. They should not be used for safety-critical information. The continuously increasing numbers of words, acronyms and abbreviations in the environment make it necessary to adopt the most common practice.

References:

ESoP (2008).

B13 Is the driving-relevant information correct?

It is of the highest importance that any information provided by an IVIS is accurate and is given at an appropriate time such that it can be integrated easily with other existing information and cues. The new information thus enhances existing information, reduces uncertainty and reduces hesitation concerning future decisions.

Accuracy of information reduces uncertainty by giving valid and clear answers to questions such as: What? When? Where? For how long? Etc. The requirement for accuracy of information also implies that it is necessary for the displayed message to match that which the driver is liable to see in the environment. Therefore, information should not conflict with, for instance, road signs, VMS or speed limits.

Examples:

Good: The distance to next manoeuvre is provided exactly at the point where the driver needs to know if a manoeuvre is to be undertaken and which manoeuvre it should be.

The system recognises the type of road, the lane the vehicle is occupying and takes account of the vehicle's speed.

Bad: A traffic message, which is no longer valid, is still displayed.

B14 Is a suitable indication given when new/updated information arrives that is directly relevant to the driver in the current driving situation?

Indication of updated information prevents the driver from having to frequently monitor the display and hence visual interaction with the IVIS will be reduced. The update should attract the driver's attention and be obvious without being distracting. It should be clear whether new information is being presented, or whether the previous information is being repeated.

Examples:

Good: The system presents an audible 'bleep', whenever new information arrives that is directly relevant to the driving task.

Bad: The last Radio Data System - Traffic Message Channel (RDS-TMC) message displayed on driver request differs only from the previous one by one item: the number of km. This item is not enhanced, which creates doubt about whether the system has recognised the user input or not.

References:

ESoP (2008).

B15 Is information of higher safety relevance given higher priority?

The driver may need to perceive and act on safety-relevant information within a short timescale. Such information therefore needs to be presented as rapidly as possible and should not be delayed by more routine information.

Information priority from the point of view of safety-relevance depends on its urgency and criticality (i.e. severity of the consequences if the information is not acted upon). These factors, in turn, also depend on the driving situation as explained in ISO/TS 16951. Where information is generated off-board (from the roadside or a remote system), prioritisation cannot take account of the driving situation and only a more generic priority allocation is possible. Where information is derived from autonomous vehicle systems, or where external and on-board information can be combined, the possibility of appreciating the driving situation exists and message priority can be refined.

For off-board information, the dynamic information providers (service providers) should implement an information dissemination strategy which, besides being current and reliable, ensures that transmission priority is given to messages with the highest importance. In-vehicle systems need to recognise incoming safety-relevant messages and treat them accordingly.

Safety relevance of information may not always be easily determined and not all information may be technically available for prioritisation.

Examples:

Good: Information concerning manoeuvring around a complex intersection is given priority over an incoming telephone call.

Bad: A high-priority message concerning ice at the current location is prevented from being delivered immediately because the information screen is in the process of displaying a message concerning distant traffic congestion.

References:

ISO TS 16951.

B16 Where the volume of auditory output cannot be adjusted, does it present any concerns?

Auditory information at a sound level which is too high may affect driving or road safety by masking significant and important warning sounds concerning road and vehicle safety.

Where the sound level (volume) produced by the system cannot be controlled by the driver, (beyond his ability to switch it on and off) auditory information needs to be designed so that the driver is not prevented from hearing interior or exterior warnings. Additionally the auditory output should not be so loud as to startle the driver, cause pain or annoyance.

Examples:

Good: Auditory signals from the system that self-adjust according to the ambient noise level within the vehicle.

Bad: The ring tone for an incoming telephone call is not adjustable, and is at a very high sound level.

References:

ESoP (2008).

Defence Standard 00-250.

ISO 5128, ISO 15006.

DIN 33404-3.

B17 Is the use of Head Up Displays (HUDs) appropriate?

The use of HUDs can be beneficial within a vehicle as they project data to a position within the user's field of view and allow the driver to view visual information without looking away from the road ahead.

Information should only be projected if it is appropriate for use on a HUD. For example, it is not appropriate to project all of the information present on the instrument panel onto the windscreen since it will take up a large amount of space which could mask important information from the road scene.

HUDs should not distract the driver and so a highly dynamic element should be avoided. The brightness and contrast should be appropriate: brightness and contrast should not be so great that they distract the driver but should be clearly perceptible to the driver. HUDs should be free from the effects of glare so that they are clearly visible to the driver.

Examples:

Good: A digital projection of speed that is within the driver's direct field of vision on the windscreen.

Bad: A large projected image that partially obscures the driver's view of the road ahead.

B18 Does presentation of information by the IVIS in combination with other vehicle systems cause conflicts?

Where an IVIS is multifunctional, for example offering congestion warning advice and navigational instruction, the presentation of information from one source, whether via a visual or auditory modality, should not conflict with presentation of information from the other. When a function of the IVIS is operational, information from a secondary function should only intervene when this will not compromise safety, for example by overloading the driver with information.

C Interaction with Displays and Controls

C1 Is the driver able to keep at least one hand on the steering wheel while interacting with the IVIS?

This question is concerned with interfaces which require the driver to provide manual control inputs (e.g. using buttons, knobs or a touchscreen).

There are driving situations which require the driver to have precise control of the vehicle's steering and this can be achieved most effectively with both hands on the steering wheel. For other driving situations, one hand on the steering wheel is acceptable as long as the other hand is immediately available for steering if circumstances demand it. That leads to the consideration that handheld devices are not recommended for use whilst driving.

The IVIS should be designed in such a way that only one hand needs to be away from the steering wheel to interact with the system, leaving one hand remaining on the steering wheel. In addition, if one hand must be removed from the steering wheel to undertake the interface, the other hand should not simultaneously be needed for interface (*e.g*. for operating fingertip controls).

Examples:

Good: A control device that is securely mounted in a conveniently positioned holder and can be used one-handed without removal from the holder.

Bad: An unfixed control device that the driver needs to hold in his hand while interacting with it.

References:

ESoP (2008).

C2 Is it easy to navigate through the IVIS menus?

Users should be able to see where they are in the IVIS menu system, how they got there and how to get back to the starting point. It should be easy to return to the start or escape from a dead end, and return or escape options should be consistent. If it is hard to navigate around IVIS menus, visual interaction time will increase.

References:

ESoP (2008).

C3 Is the manual-visual interaction short or interruptible?

Inputs should be limited to a small number of keystrokes so that driver interaction time with the IVIS is minimised. The system should therefore not require long sequences of interactions.

A sequence of interactions is a related set of successive inputs/outputs also called a dialogue, e.g. entering a new destination or a phone number, memorising a radio station.

"Short" remains to be defined, but the checklist suggests three inputs or less. However, short can be interpreted in a number of ways, which include the following considerations:

- The complexity of the interaction (e.g. 2 menu inputs)
- The number of individual control inputs (e.g. 5 button presses)
- The time to make the control inputs (e.g. 5 seconds)

Short may also be differently defined according to the visual demand of the interaction.

Examples:

Good: Dialling is automatically performed after the driver has named the correspondent by voice.

Bad: A series of 11 key presses are required to enter a telephone number.

References:

ESoP (2008).

SAE J 2364.

C4 Is the driver able to resume an interrupted dialogue with the IVIS at the point of interruption or at another logical point?

If partly entered data disappears when an input sequence is interrupted, the driver may be tempted to go through the full sequence even if the driving situation requires full attention.

The driver should be allowed to continue an interrupted interface sequence (with no need to restart it) either from the point of interruption or from another previously completed step.

When the driver resumes the sequence, it may happen that some events have made the point of interruption no longer relevant. In such cases, the logical point provided by the system will simplify the task and lessen the workload.

Examples:

Good: The driver can interrupt entering a phone number, look for several seconds at the road scene and then complete the partly entered number.

Bad: When the driver is reading a list of traffic messages and interrupts viewing halfway through the list, the system cancels the list after a short time-out period. Consequently the driver needs to "call" the list again in order to resume reading.

C5 Is the IVIS free from "machine pacing"?

In all driving situations it is of paramount importance that the driver can direct their attention to the road scene to the extent required and that all the interactions with the system can be performed when the traffic situation permits. Thus, the driver should be able to control the pace of interaction with the system.

The term "machine pacing" indicates that the system requires a response within a limited time period. If the response is not given within this time, the system state may change. This should be avoided so that the driver is not encouraged to divert attention

from the road when it may be inappropriate. Equally, visual feedback should persist long enough for the driver to observe it in his own time, so that he does not compensate by increasing visual interaction time with the IVIS.

Interaction with the system refers here to making an input by a control action, or by a voice, into the system, either at the driver's initiative or as a response to displayed information initiated by the system itself. Depending on the type of task and the goal, the interaction may be elementary (a single input/output couple) or made of a sequence of several couples of input/output (e.g. entering a phone number, scrolling through a series of stored messages).

The pace of interaction refers to the time allotted to the driver for making an input, at any step of a sequence, and to the time during which outputs are displayed by the system.

It may be that information is needed to inform driving strategy, e.g. in the case of navigation systems. Information relevant to the driving task should be timely and accurate, thus information must be provided sufficiently in advance of driving decisions, so that the driver has time to make decisions and take action safely.

Information relevant to the driving task covers information on aspects of the vehicle which are mandatory or which are related to safety or which are related to the road and traffic environment and on driver related infrastructure services. Examples include:

- Navigation and route guidance
- Tyre and brake parameters
- Proximity of other vehicles
- Congestion information
- Parking information
- Ice warning
- Speed limits

Timely is to be interpreted here as the moment which is most appropriate to help the driver to deal adequately with the situation. The right information at the right time should be the rule.

The driver is able to control the pace if he/she always remains in command of the time before which input must be provided and the time for which the output is displayed. There may be occasions when the driver is distracted during presentation of the auditory information and may wish to hear the message again. Ideally, the system should therefore enable the last message to be repeated at a simple button press.

Examples:

Good: The driver can choose to listen to incoming traffic messages when the situation permits and is not automatically presented with a message when it arrives.

Bad: Advance information concerning a pending turn manoeuvre within a guidance system is only visually displayed for a few seconds.

References:

ESoP (2008).

ISO 15005.

C6 Is the IVIS control layout suitable for safe operation?

IVIS controls should be designed such that they can be operated without adverse impact on the primary driving task.

The minimum requirement is that IVIS use is fully compatible with the primary driving task. In this regard, the usability of controls is one of the most important factors.

IVIS controls are all elements of the system interface through which the driver provides control inputs. These include turn-knobs, buttons, touch-screens, joysticks, pedals, and microphones. Adverse impact occurs when badly designed controls induce negative consequences on the ability of the driver to undertake correctly the primary driving task. Poor control design may involve their layout.

Controls that need to be located non-visually should be positioned at least 150mm away from other controls to avoid manual input errors. Controls that have a similar function should be grouped together.

References:

ESoP (2008).

ISO 4040.

SAE J 1138.

Sanders, M.S. and McCormick, E.J. (1992). *Human Factors in Engineering and Design*. McGraw-Hill, Inc.: New York.

C7 Is the volume of auditory output adjustable over a reasonable range?

Auditory information at a sound level which is too high may affect driving or road safety by masking significant and important warning sounds concerning road and vehicle safety.

Auditory information needs to be designed such that the driver is not prevented from hearing interior or exterior warnings. Additionally, an auditory output should be adjustable such that it is not so loud as to startle the driver or cause pain or annoyance.

The sound level (volume) produced by the IVIS may or may-not be controlled by the driver. Ideally, the volume of an auditory output will be adjustable by the driver. The ability to turn an auditory output on and off does not constitute an adjustable control, unless the volume can be adjusted further by the driver within an adequate range.

Examples:

Good: Auditory signals from the system are adjustable by the driver according to the ambient noise level within the vehicle.

Bad: The entering telephone call is at a very high sound level, and out of the driver's control.

References:

ESoP (2008).

ISO 5128, ISO 15006.

DIN 33404-3.

Defence Standard 00-250.

C8 Is immediate feedback provided when an input error is made?

Drivers should receive clear indication that an input error has been made, in order to avoid confusion and prevent any unnecessary increase in visual or manual interaction with the IVIS.

The system's response is timely if it is perceived as quite instantaneous, i.e. within a time of 250 ms. For control activation feedback timing should be from the moment at which the system recognises each driver input.

References:

ESoP (2008).

C9 Is control activation feedback adequate and appropriate?

The IVIS must provide the driver with feedback about control actions taken and the state of the system, to avoid uncertainty and distraction from the driving task. The systems response (e.g. feedback, confirmation) following driver input should be timely and clearly perceptible. Control action feedback indicates to the user that they have been successful in activating the control. The control activation feedback could be auditory, tactile or visual, e.g. button displacement, or an auditory beep. If the driver is not sure whether or not he has activated the control, workload or visual distraction may increase.

The system's response is clearly perceptible if it is obvious to the driver that a change has occurred in the system and that this change is the consequence of the input. If the change within the system that results from a given input is not systematically the same but depends on one or more previous steps of the sequence, it may be advisable to provide help (on driver request).

References:

ESoP (2008).

C10 Following control activation feedback, is the required information provided within an appropriate timescale?

The IVIS response (e.g. feedback, confirmation) following driver input should be timely and clearly perceptible; if there is a time lag visual distraction may increase or the driver may try and activate the control again.

The timing for requested information, or an indication that processing is underway should start from the end of the driver's input. When the system's processing time requires longer than 250 ms, some signal should be displayed within 250 ms to inform the driver that the system has recognised the input and is preparing the requested response.

Additionally, visual feedback should persist long enough for the driver to observe it in his own time, so that he does not compensate by increasing visual interaction time with the IVIS.

Any delayed, ambiguous or uncertain system response may be misinterpreted, may be taken as an error by the system or by the driver, and may lead to the driver making a second input.

Examples:

Good: A message "BUSY" is displayed immediately following a driver request to change the area shown on a map.

Bad: A long delay before acknowledgement of the driver's request for information.

References:

ESoP (2008).

C11 Can dynamic non-safety related information be deselected?

Visual information is dynamic if it changes without user input or interaction, e.g. automatic updates of a map. Non-safety-related information is information which is not relevant to the driver in avoiding or reducing the risk of an immediate or imminent hazardous situation.

Examples of non-safety-related information include navigation map, freight and fleet data, banking services.

Since an unacceptable distraction from the driving task may be caused by a dynamic presentation of non-safety-related information, the driver should be able to switch the information off.

Examples:

Good: The driver can select from a menu whether non-safety-related dynamic visual information is displayed or not.

Bad: A navigation map, which is updated every second, cannot be switched off without losing complete guidance support.

C12 Is the design of the IVIS controls suitable for their function?

IVIS controls should be designed such that they can be operated without adverse impact on the primary driving task.

The minimum requirement is that IVIS use is fully compatible with the primary driving task. In this regard, the usability of controls is one of the most important factors.

IVIS controls are all elements of the system interface through which the driver provides control inputs. These include turn-knobs, buttons, touch-screens, joysticks, pedals, and microphones, (which is a voice-input control). Adverse impact on the driving task occurs when badly designed controls induce negative consequences on the ability of the driver to undertake correctly the primary driving task.

Poor control design may involve their shape and design. Controls should be designed to reduce manual interaction time wherever possible. Controls that require fine adjustment are unsuitable for use while driving.

Poor control design may involve their logic of activation. Controls should conform to control action stereotypes to avoid errors in high workload situations, for example, to turn on, switch down, switch up to turn off, to increase (eg. volume) rotate right, to reduce (e.g. volume) rotate left.

Poor control design may involve their labels. Control labels should therefore conform to stereotypical norms, for example a red label for 'hazard/emergency' controls.

References:

ESoP (2008).

BS 5499-5.

SAE J 1139.

ISO 2575, ISO 80416-4, ISO 7000, ISO 7001.

C13 Is the use of non-contact input controls (e.g. speech) appropriate for their function?

Non-contact input controls, such as speech recognition input, can provide a safety benefit whilst driving since the user does not need to move their hands from the steering wheel or take their eyes off of the road. Speech input is most appropriate for use with functions of the IVIS that do not require long speech input or a large number of words in the speech input vocabulary to increase recognition accuracy by the system. Speech input should not be used if input is highly time critical.

The user should be able to turn the speech recogniser off and an alternative method of input should be provided for users who have a speech impairment or a strong accent, or for users who want to reduce unwanted entries (e.g. if they are talking to passengers in their vehicle).

References:

ETSI EG 202 116.

ISO TR 22411.

C14 Are touchscreens easy to use?

Touchscreens are a common feature of IVIS since they enable an overall reduction in the size of the device, therefore minimising the obstruction to the driver's vision.

Each button, or "target", should be of a sufficient size with a sufficient inactive area around each target to avoid accidental activation of adjacent functions.

Feedback should be provided to the user once a target has been activated by auditory output or tactile output and targets should not be overly sensitive.

D System Behaviour

D1 Does the IVIS display distracting images unrelated to driving?

The importance of the visual modality for safe driving is emphasised. Visual information from within the vehicle which can provide a distraction from the primary driving task should be limited. Likelihood of significant distraction refers to modes of presentation where the information has a dynamic and unpredictable component such that the entirety of information presented cannot be obtained by the driver with a few brief glances (e.g. TV, video and automatically scrolling images and text).

One example is automatically scrolling images and text that cover a variety of forms of dynamic presentation where the driver is not able to pace the presentation and where the entire information is not available at any one time. Other specific modes of presentation, e.g. "Internet pages", should be examined within the context of these examples. Scrolling lists under the control of the driver, such as navigation system destinations, are not within the scope of this question as the driver can always interrupt and resume the interface.

Even after a vehicle comes to a halt, it is recommended that a time delay of a few seconds be included before dynamic images are activated. This deals, at least partially, with the situation of divided attention of the driver in "stop-and-go" traffic conditions.

Examples:

Good: A TV picture which goes blank when the vehicle is in motion and does not reappear immediately when the vehicle stops.

Bad: A passenger entertainment system which can be seen by the driver while the vehicle is in motion.

References:

ISO 15005, ISO 4513.

D2 Does the behaviour of the IVIS adversely interfere with displays or controls required for the primary driving task and for road safety?

The driver's ability to be in full control of the vehicle should not be affected (in a way which compromises safety) by the behaviour of the IVIS during normal operation or failure. This means that the system should not override information or controls necessary for the safe operation of the vehicle. In this context, interference is any influence or interface which modifies the performance, characteristics or behaviour of existing displays or controls.

Adverse interference with displays or controls results in overall impairment of performance (from that intended) of the display or control. Examples include changes to mandatory displays or controls. In addition, the behaviour of a system should not obstruct or render inoperative other systems which are specifically intended as safety systems.

Examples:

Good: On a multipurpose display, navigation directions are given in such a way that the speedometer always remains easily readable.

Bad: On a multipurpose display, mandatory information is overlaid by radio station identification information.

References:

ISO 4040.

D3 Are system functions that are not intended to be used by the driver when driving impossible to interact with when the vehicle is in motion?

This question seeks to ensure clarity, particularly for the driver, in terms of the manufacturer's intention for use of the IVIS. If this principle is complied with, subsequent use of the system outside the scope of intended use can be considered as misuse.

"Impossible" in this context means that the designated IVIS function is not operable by the driver during normal use or during reasonably foreseeable misuse. In this context, it would not be reasonable for a manufacturer to anticipate that a driver would undertake

sophisticated technical measures to defeat the manufacturer's intentions. The manufacturer's rationale may be based on regulation or their own judgement.

Examples:

Good: When the vehicle starts to move, the driver's interface with an internet website is cancelled and a message "not available while driving" is displayed. When the vehicle comes to a full stop, the driver can resume the interface.

Bad: A television facility is designated as an unavailable function while the vehicle is in motion as detected by a handbrake position sensor. The sensor on the handbrake can be deactivated by a partially engaged handbrake. (This is an example of misuse which is reasonably foreseeable and should, therefore, have been designed out, or clear warnings provided).

References:

ISO 15005, ISO 17287.

D4 Does the supplier make it sufficiently clear that the driver retains absolute responsibility for the operation of the vehicle and compliance with traffic regulations regardless of information provided by the IVIS?

Regardless of any information received from the IVIS, the driver retains responsibility for the safe operation of the vehicle, and compliance with presiding traffic regulations. This should be made clear in the user instructions.

A clear warning gives information or advice about the negative consequences of a situation or action in sufficient detail. The warning is available in such a way or form that the driver can readily perceive it. It can be written information or an automatic display by the IVIS. Reasonable drivers should be in no doubt concerning the use of the system intended by the manufacturer after taking account of the clear warning.

There are a number of ways of conveying warnings. A continuously displayed warning is one option. If the warning is not continuously displayed, then it should remain available for a sufficient duration to ensure that the driver has the opportunity to become aware of it. One suitable solution is for the driver to acknowledge the warning by pressing a button.

D5 Is information presented to the driver about current status and any malfunction within the IVIS?

Information may be lost if the driver is unaware of the current status of the IVIS. Feedback about the status of auditory information channels should be presented every time the system is turned on.

References:

ISO 15008, ISO 15005.

E Information about the System

E1 Does information available to the driver include clear recommendations for installation of the IVIS?

The size and quality of any text and diagrams should be adequate for the user. Print should not be smudged or too small to read and written instructions should be presented on a material that is adequately durable. If instructions are only available in the form of 'help functions' these should be designed in a way that allows their operation without prior reading of the material.

Examples:

Good: Good quality printed colour manual on A5 pages with text and illustrations which fits within the glove box.

Bad: Instructions which are only on the packaging material which are likely to be discarded.

E2 Does the information available to the driver include adequate instructions for use and maintenance?

In order to ensure the continued safe operation of the IVIS, and to ensure that drivers are made aware of their responsibilities, the user manual should outline the maintenance requirements of the IVIS.

The size and quality of text and diagrams should be adequate for the user. Print should not be smudged or too small to read and written instructions should be presented on a material that is adequately durable. If instructions are only available in the form of 'help functions' these should be designed in a way that allows their operation without prior reading of the material.

Examples:

Good: Good quality printed colour manual on A5 pages with text and illustrations which fits within the glove box.

Bad: Instructions which are only on the packaging material which are likely to be discarded.

E3 Are the IVIS instructions correct and simple?

Design of user instructions is an HMI issue in itself. Instructions are typically ignored by drivers and this is exacerbated by poor design of the instructions. This principle is intended to promote high acceptance of instructions by drivers.

Instructions should be factually accurate in all important aspects. Each element of the instructions (group of words, diagram, function-described, etc.) should be correct for the actual system to which it relates.

Simple has to be interpreted in the context of the system being described and will vary with the complexity and functionality of the system. The instructions should be unambiguous and easy to understand, if possible by all members of the intended user population (*e.g.* documents in "Plain Language"). Instructions should not be overly technical and should use user-oriented language. It is important that the instructions are simple even if the system is complex.

Examples:

Good: Good examples might be expected to have some of the following features: well presented manual with factually accurate text and diagrams, contents page, page numbers, good use of colour, written in a plain language style using common words, good Index, use of different fonts, italics, bold, underline, etc. to distinguish portions of the text.

Bad: Instructions which refer to a previous model with different functions and controls.

E4 Are IVIS instructions in languages or forms designed to be understood by the intended group of drivers?

The aim of this question is to ensure that instructions are of use to as many drivers as possible and that drivers are aware of the capabilities and limitations of the system, its context of use, etc.

Different forms of instructions may exist which could be presented in different modalities: Auditory instructions may be spoken or presented by means of noises or earcons. Visually presented information includes diagrams, photographs, highlighting of the next element, programmed tutorials, etc.

Spoken instructions and written instructions (either printed or within a system) will be in one or a number of languages (e.g. English, Finnish, etc.)

This principle requires that when instructions are being devised, consideration is given to the intended and most likely driver population, and those instructions can reasonably be expected to be understood and used by as many drivers as possible.

Manufacturers should consider the driver population and the likely and intended use of the system as well as the native languages and other languages spoken and read. Published statistics on language proficiency by country could be used as a reference. At the very least, the majority language of the country in which the system is sold should be considered necessary. Diagrams often provide additional clarity. Where used, these should follow accepted stereotypes and conventions for the intended population.

Examples:

Good: For a system sold in Sweden, instructions are formulated in easily understandable Swedish and incorporate pictorial help at relevant passages.

Bad: Written instructions (without diagrams or photographs) automatically translated from Japanese (unedited) for a system presented for sale on the European market.

E5 Do instructions provide sufficiently clear recommendations for non-use of any of the functions whilst driving?

Certain functions may require lengthy interaction time and significantly increase workload while driving, therefore posing a threat to safety. The supplier should either prevent the use of these functions, or clearly state that they are not to be used while the vehicle is in motion.

System functions not intended to be used by the driver while driving should be made impossible to interact with while the vehicle is in motion, or clear warnings should be provided against the unintended use.

The instructions should clearly state which aspects of the system are intended for use by the driver while driving and those aspects (e.g. specific functions, menus etc.) which are not intended to be used while driving.

Unintended aspects of system use are those functions that are designated as such by the supplier. If not specifically designated as unintended, it can be assumed that the aspect of use is intended.

After becoming aware of the instructions, reasonable drivers should be in no doubt about which aspects of the system have been designed for use while driving (i.e. the intended use of the system). They should also be in no doubt about those aspects which have not been designed for use while driving.

There are driving situations which require the driver to have precise control of the vehicle's steering and this can be achieved most effectively with both hands on the steering wheel. For other driving situations, one hand on the steering wheel is acceptable as long as the other hand is immediately available for steering if circumstances demand it.

There are also emergency situations where the driver needs both hands for steering e.g. to make an evasive manoeuvre. This leads to the consideration that handheld devices are not recommended for use whilst driving.

Freestanding equipment that requires hand-held operation (e.g. mobile phone use) will reduce the driver's ability to control the vehicle. Prolonged manual interaction of this kind presents additional risks to safety, which should be regarded as serious. The only acceptable handheld remote controls are those which are commonly used when the vehicle is not in traffic, e.g. remote controls used to open a garage.

Examples:

Good: Instructions for a mobile phone which state that the hand-set is not intended for use in a moving vehicle (and the hand-set is disabled and switches to hands free microphone/speaker when the vehicle is in motion).

Bad: A feature-rich driver information and communications system which has additional functionality for use by a passenger, or driver while stationary, but whose instructions make no clear distinction concerning the features intended for use by the driver while driving.

References:

ESoP (2008).

DfT Advisory Leaflet (2006).

E6 Does the product information accurately convey the IVIS functionality?

The aim of this question is to encourage good design of all product information and to assist potential or current users of the system in appreciating the benefits and limitations of the system.

All product information should be factually correct and presented transparently and without ambiguity. Information does not have to be comprehensive to be accurate.

Functionality is concerned with what the IVIS does and, by implication, the benefits that the functionality provides to the driver. Functionality should distinguish between that which is designed to be used by the driver while driving and that which is not, i.e. the information should not claim or imply that a function which has not been designed to be used while driving can be so used. The product information should make it clear if additional software or hardware is required (other than that supplied with the base model) for specific functionality.

Product information must be in line with consumer protection requirements, EU regulations and existing codes concerning advertising, and all product information should conform to the report on advertising.

Examples:

Good: A communications system which is not designed to store telephone numbers while driving provides the information that "pre-stored numbers can be selected using a single button".

Bad: The same communications system provides the information "Telephone numbers can be stored for later use" adjacent to a picture of a driver and vehicle in motion. This association implies that number storage is designed for use while driving.

E7 Does the product information make it clear if special skills are required to use the IVIS as intended by the manufacturer?

The manufacturer's intention as regards to the target group should be made clear to potential and actual users of the system. The normal presumption is that a system can be used by all drivers. However, initial training may be required; for example, for systems designed for specialist professional use. Although all drivers are required to have a minimum level of (far) vision, other capabilities may vary considerably and this includes the capabilities of drivers with special needs.

This principle is also designed to encourage compliance with consumer protection requirements, EU regulations and existing codes concerning advertising.

Product information refers to any information that the driver has access to concerning the system. It includes system instructions, technical specifications, promotional materials, packaging, etc. However, full workshop and technical manuals are excluded from the scope of this principle.

The need for special skills and the unsuitability for particular user groups are matters for definition by the manufacturers. If any special skill requirement or initial training is envisaged by a manufacturer, then all product information should make this clear. Similarly, any restriction on use intended by the manufacturer should be described in the product information.

Examples:

Good: The product information makes it clear that routing instructions are provided exclusively using the auditory modality and the system is therefore unsuitable for drivers with a hearing impairment.

Bad: A voice input system only works reliably with deep male voices, but this limitation is not made clear in the product information.

E8 Are unrealistic expectations and encouragement of unsafe use avoided?

Representations of IVIS use (e.g. descriptions, photographs and sketches) should neither create unrealistic expectations on the part of potential users nor encourage unsafe or illegal use. Rather, they should assist the driver in appreciating the functionality, benefits and limitations of the system before (and during) use, and promote road safety and compliance with existing traffic Regulations and codes of road and vehicle use.

Representations of IVIS use include those provided by the supplier in instruction manuals (diagrams etc.), photographs, films, computer animations, sound clips and any form of product information or advertising that users or potential users of the system may be exposed to.

Examples:

Good: Photographs of the IVIS being used as intended by the supplier and following all relevant codes and Regulations.

Bad: A photograph showing a hand-held telephone being used while driving.

References:

ESoP (2008).

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Appendix 2 Abbreviations and Glossary

Abbreviations

BSI	British Standards Institution
DIN	Deutsches Institut fur Normung E V
DIS	Draft International Standard
ESoP	European Statement of Principles
ISO	International Organisation for Standardisation
IVIS	In-Vehicle Information System
RDS	Radio Data System
SAE	Society of Automotive Engineers
VMS	Variable Message Sign

Glossary

Ambient Lighting	Surrounding light environment.
Configure	Arrange.
Convention	Established customary practice.
Design Posture	Position adopted by the driver following adjustments for reach, field or vision, comfort, etc. Note: In-vehicle design posture can be established by putting on a seatbelt, adjusting the seat so that the foot pedals and steering wheel can be reached and operated comfortably, and ensuring that it is possible for the driver to see comfortably through the windscreen and into all mirrors.
Dialogue	Related set of successive inputs and outputs with the system.
Feedback	Response from the IVIS giving information to the user about an input action taken, further action that is required, or a change in system state.
Function	Operation or activity carried out by the IVIS that is executed on a reception of incoming information, and transforms this into an information output.
Glare	Distracting (and potentially disabling) effect of bright light in an otherwise relatively dark scene that interferes with visual attention and selection. Note: In the in-vehicle context, this can occur in a number of ways: External light (usually sunlight) falls on the visual display reducing display contrast and makes the information on the screen more difficult to see from the driver's normal viewing position. The display is itself too bright and causes distraction from the road scene and other in-vehicle displays and controls. This is most likely to be apparent to the driver in low ambient light conditions.
Graphics	Symbolic drawing or illustration used to present visual information, without the use of text or numbers.
Hue	Tint of colour.
Machine Pacing	Speed at which the user must interact with the system is

	determined by the system rather than by the user.
Manufacturer	Person or organisation responsible for system construction. Note 1: The term includes designer, component supplier and system integrator. Note 2: The term includes system suppliers who, by putting a name, trade mark or other distinguishing feature on a product, presents themselves as its producer. Note 3: The responsible organisation will typically be the vehicle manufacturer or the system supplier.
Masking	Covering, concealing.
Misuse	IVIS functions intended by the supplier for use while driving, are used by the driver in a manner or way that is not intended, and may lead to negative consequences.
Reasonably Foreseeable Misuse	Use of IVIS in a way that is not intended, but which the suppliers might be expected to have anticipated.
Redundant	Can be omitted without loss of significance.
Reflection	Reflection is the generation of a secondary image of an object as a result of light from the object bouncing off intermediate surfaces. Note: This is relevant for IVIS in a number of ways: • Light from a light emitting display travels to another surface (or via several surfaces) producing a secondary image of the display screen for example, on the windscreen. This is most likely to be perceived by the driver when there is high contrast between the secondary image and its background, such as against the windscreen during darkness. • Light from an external source (e.g. the sun, streetlights, or other bright objects) is reflected by the display surface into the driver's eyes (see also Glare above).
Reversing Out	White characters against a black background.
Supplier	Organisation(s) responsible for design, and production of the system, which designate the envelope of use for the system and provide related documentation.
Free-standing Equipment	Free-standing equipment is a device that is not securely mounted or installed within the vehicle, that may require hand held operation, for example a remote control device or mobile phone.
Unintended Use	Use of IVIS functions while driving that are not intended by the supplier for use while driving.
Usability	Ease with which the IVIS can be used.
Visual After Effects	Visual disability occurring after being exposed to a relatively bright light source. Note: The eye takes time to recover and visual disability may occur due to the prolonged presence of the image of the light source on the retina.
Workload	Physical and or cognitive demands made on an individual at any given moment.

Appendix 3 ESoP (2008) and Checklist Table of Correspondence

ESoP Principle	Corresponding Checklist Questions
Installation Principle 1 The system should be located and securely fitted in accordance with relevant regulations, standards and manufacturers' instructions for installing the system in vehicles.	A1 Is the IVIS fitted in accordance with the manufacturersinstructions for installing the system in vehicles? A2 Is the IVIS securely fitted? A3 Once positioned and secured are the relevant components of the IVIS stable? A4 Once positioned and secured are the relevant components of the IVIS free from shake? A5 Are the IVIS controls easily reached by the user when driving?
Installation Principle 2 No part of the system should obstruct the driver's view of the road scene.	A6 Is physical and visual access to the IVIS free from obstruction by other driver controls/displays? A7 Is the driver's view of the road scene free from obstruction by the IVIS?
Installation Principle 3 The system should not obstruct vehicle controls and displays required for the primary driving task.	A8 Is physical and visual access to primary driver controls free from obstruction by the IVIS and its mounting? A9 Is physical and visual access to primary driver displays free from obstruction by the IVIS and its mounting?
Installation Principle 4 Visual displays should be positioned as close as practicable to the driver's normal line of sight.	A10 Is the IVIS visual display positioned within the driver's normal line of sight?
Installation Principle 5 Visual displays should be designed and installed to avoid glare and reflections.	A11 Is the IVIS free from reflections and glare under all ambient lighting conditions? A12 Are the windscreen and windows free from reflections and/or glare caused by the display?

ESoP Principle	Corresponding Checklist Questions
Information Presentation Principle 1 Visually displayed information presented at any one time by the system should be designed in such a way that the driver is able to assimilate the relevant information with a few glances which are brief enough not to adversely affect driving.	B1 Is the visual message simple? B2 Is each control easily discernible by different methods in daylight and during darkness? B3 Is colour used effectively to aid coding and layout of controls? B4 Are colours used effectively in the design and presentation of visual images? B5 Are the displays lit during darkness without unduly affecting vision? B6 Does the lighting of controls during darkness affect vision?
Information Presentation Principle 2 Internationally and/or nationally agreed standards relating to legibility, audibility, icons, symbols, words, acronyms and/or abbreviations should be used.	B7 Is the auditory message appropriate for the information to be conveyed? B8 Is information presented by speech clearly audible? B9 Is the layout of graphics/representational features appropriate? B10 Is numerical data presented appropriately? B11 Is the choice of words appropriate? B12 Are abbreviations used appropriately?
Information Presentation Principle 3 Information relevant to the driving task should be accurate and provided in a timely manner.	B13 Is the driving-relevant information correct? B14 Is a suitable indication given when new/updated information arrives that is directly relevant to the driver in the current driving situation?
Information Presentation Principle 4 Information with higher safety relevance should be given higher priority.	B15 Is information of higher safety relevance given higher priority?
Information Presentation Principle 5 System-generated sounds, with sound levels that cannot be controlled by the driver, should not mask audible warnings from within the vehicle or the outside.	B16 Where the volume of auditory output cannot be adjusted, does it present any concerns?

ESoP Principle	Corresponding Checklist Questions
	Additional questions: B17 Is the use of Head Up Displays (HUDs) appropriate? B18 Does presentation of information by the IVIS in combination with other vehicle systems cause conflicts?
Interaction with Displays and Controls Principle 1 The driver should always be able to keep at least one hand on the steering wheel while interacting with the system.	C1 Is the driver able to keep at least one hand on the steering wheel while interacting with the IVIS?
Interaction with Displays and Controls Principle 2 The system should not require long and uninterruptible sequences of manual-visual interface. If the sequence is short, it may be uninterruptible.	C2 Is it easy to navigate through the IVIS menus? C3 Is the manual-visual interaction short or interruptible?
Interaction with Displays and Controls Principle 3 The driver should be able to resume an interrupted sequence of interface with the system at the point of interruption or at another logical point.	C4 Is the driver able to resume an interrupted dialogue with the IVIS at the point of interruption or at another logical point?
Interaction with Displays and Controls Principle 4 The driver should be able to control the pace of interface with the system. In particular the system should not require the driver to make time-critical responses when providing inputs to the system.	C5 Is the IVIS free from "machine pacing"?
Interaction with Displays and Controls Principle 5 System controls should be designed in such a way that they can be operated without adverse impact on the primary driving controls.	C6 Is the IVIS control layout suitable for safe operation?
Interaction with Displays and Controls Principle 6 The driver should have control of the loudness of auditory information where there is likelihood of distraction.	C7 Is the volume of auditory output adjustable over a reasonable range?
Interaction with Displays and Controls Principle 7 The system's response (e.g. feedback, confirmation) following driver input should be timely and clearly perceptible.	C8 Is immediate feedback provided when an input error is made? C9 Is control activation feedback adequate and appropriate? C10 Following control activation feedback, is the required information provided within an appropriate timescale?

ESoP Principle	Corresponding Checklist Questions
Interaction with Displays and Controls Principle 8 Systems providing non-safety-related dynamic visual information should be capable of being switched to a mode where that information is not provided to the driver.	C11 Can dynamic non-safety related information be deselected?
	Additional questions: C12 Is the design of the IVIS controls suitable for their function? C13 Is the use of non-contact input controls (e.g. speech) appropriate for their function? C14 Are touchscreens easy to use?
System Behaviour Principle 1 While the vehicle is in motion, visual information not related to driving that is likely to distract the driver significantly should be automatically disabled, or presented in such a way that the driver cannot see it.	D1 Does the IVIS display distracting images unrelated to driving?
System Behaviour Principle 2 The behaviour of the system should not adversely interfere with displays or controls required for the primary driving task and for road safety.	D2 Does the behaviour of the IVIS adversely interfere with displays or controls required for the primary driving task and for road safety?
System Behaviour Principle 3 System functions not intended to be used by the driver while driving should be made impossible to interact with while the vehicle is in motion, or, as a less preferred option, clear warnings should be provided against the unintended use.	D3 Are system functions that are not intended to be used by the driver when driving impossible to interact with when the vehicle is in motion? D4 Does the supplier make it sufficiently clear that the driver retains absolute responsibility for the operation of the vehicle and compliance with traffic regulations regardless of information provided by the IVIS?
System Behaviour Principle 4 Information should be presented to the driver about current status and any malfunction within the system that is likely to have an impact on safety.	D5 Is information presented to the driver about current status and any malfunction within the IVIS?

ESoP Principle	Corresponding Checklist Questions
Information about the System Principle 1 The system should have adequate instructions for the driver covering use and relevant aspects of installation and maintenance.	E1 Does information available to the driver include clear recommendations for installation of the IVIS? E2 Does the information available to the driver include adequate instructions for use and maintenance?
Information about the System Principle 2 System instructions should be correct and simple.	E3 Are the IVIS instructions correct and simple?
Information about the System Principle 3 System instructions should be in languages or forms designed to be understood by the intended group of drivers.	E4 Are IVIS instructions in languages or forms designed to be understood by the intended group of drivers?
Information about the System Principle 4 The instructions should clearly state which functions of the system are intended to be used by the driver while driving and those which are not.	E5 Do instructions provide sufficiently clear recommendations for non-use of any of the IVIS functions whilst driving?
Information about the System Principle 5 Product information should be designed to accurately convey the system functionality.	E6 Does the product information accurately convey the IVIS functionality?
Information about the System Principle 6 Product information should make it clear if special skills are required to use the system as intended by the manufacturer or if the product is unsuitable for particular users.	E7 Does the product information make it clear if special skills are required to use the IVIS as intended by the manufacturer?
Information about the System Principle 7 Representations of system use (e.g. descriptions, photographs and sketches) should neither create unrealistic expectations on the part of potential users nor encourage unsafe use.	E8 Are unrealistic expectations and encouragement of unsafe use avoided?

Appendix 4 Checklist Feedback Sheet

We are always looking for ways to improve the Checklist for the Assessment of In-Vehicle Information Systems and so any feedback you have, good or bad, would be appreciated. If you would like to provide feedback, please complete the form and return it to enquiries@trl.co.uk.

Name: Date: Organisation: Type of device/functions assessed: If you are happy to be contacted about your comments, please provide an email address:

Positive aspects of the Checklist and supportive information:

Negative aspects of the Checklist and supportive information:

Suggestions for improvement:

Additional comments:

Checklist for the assessment of in-Vehicle information systems

A Checklist for the assessment of In-Vehicle Information Systems (IVIS) was published in 1999 which provided a structured approach for assessing the interface design of an IVIS. Since the publication, there have been several advances in technology and a number of developments in ergonomics standards and road safety. This publication has updated the Checklist to include such developments and advances.

Other titles from this subject area

PPR568	Revision of the checklist for the assessment of in-Vehicle information systems. A Stevens, S Cynk and R Beesley. 2011
PPR470	UK eCall Impact Assessment. A Stevens and J Hopkin. 2010
PPR389	Update of the safety checklist for the assessment of in-vehicle information systems: a scoping study. S Cynk and D Basacik. 2009
PPR294	Research on the manufacturing of DSRC Tags: summary of results for publication. D W Tindall. 2008
PPR259	Occlusion Protocol. T Horberry, A Stevens, S Cotter, R Robbins and G Burnett. 2007
PPR256	Development of an Occlusion Protocol with design limits for assessing driver visual demand. T Horberry, A Stevens, S Cotter, R Robbins and G Burnett. 2007
PPR175	A code of practice for developing advance driver assistance systems: final report on work in the RESPONSE 3 project. S Cotter, J Hopkin and K Wood. 2007
PPR093	Routing assessment of dynamic route guidance systems. K Wood, A Maxwell, A Stevens and S Thompson. 2006
PPR091	Guidelines for safe and effective vehicle routing. S Thompson, A Stevens, A Maxwell and K Wood. 2006

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