TECHNICAL SPECIFICATION

ISO/TS 15007-2

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Road vehicles — Measurement of driver visual behaviour with respect to transport information and control systems —

Part 2: Equipment and procedures

Véhicules routiers — Mesurage du comportement visuel du conducteur en relation avec les systèmes de contrôle et d'information sur le transport —

Partie 2: Équipement et procédures

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

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An ISO/PAS or ISO/TS is reviewed after three years with a view to deciding whether it should be confirmed for a further three years, revised to become an International Standard, or withdrawn. In the case of a confirmed ISO/PAS or ISO/TS, it is reviewed again after six years at which time it has to be either transposed into an International Standard or withdrawn.

Attention is drawn to the possibility that some of the elements of this part of ISO/TS 15007 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TS 15007-2 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 13, *Ergonomics applicable to road vehicles*.

ISO/TS 15007 consists of the following parts, under the general title *Road vehicles — Measurement of driver visual behaviour with respect to transport information and control systems*:

Part 1: Definitions and parameters

Part 2: Equipment and procedures

Introduction

This Technical Specification supports ISO 15007-1, which defines key terms and parameters for the assessment of the visual impact on driver visual behaviour of TICS (Traffic Information Control Systems), and other vehicle tasks or on-board systems.

ISO/TS 15007-2 supports Part 1 by giving guidance on equipment and procedures that can be used in a practical TICS evaluation, with recommendations on how to interpret selected metrics (standards of measurement) of visual behaviour.

Road vehicles — Measurement of driver visual behaviour with respect to transport information and control systems —

Part 2: Equipment and procedures

1 Scope

This Technical Specification gives guidelines on equipment and procedures for analyzing driver visual behaviour, intended to enable assessors of transport information and control systems (TICS) to

— plan evaluation trials,

— specify (and install) data capture equipment, and

— analyse, interpret and report visual-behaviour metrics (standards of measurement).

It is applicable to both road trials and simulated driving environments. It is not applicable to the assessment of head-up displays.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this part of ISO/TS 15007. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO/TS 15007 are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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

3 Terms and definitions

For the purposes of this part of ISO 15007, the terms and definitions given in ISO 15007-1 apply.

4 Evaluation trial planning

4.1 Subject selection

Evaluation trials of TICS applications should use a representative sample from the target population for the specific TICS. This driver sample should be able to be categorized by age, sex, visual ability and driving experience.

4.2 Trial procedures

4.2.1 General

Assessment of driver visual demand can be carried out in relation to many forms of TICS applications and road environments. Therefore, consideration should be given to the following factors influencing driver visual behaviour.

4.2.2 Roadway/traffic specification

An appropriate operational environment for the specific TICS application under evaluation should be chosen. The type of roadway and likely traffic conditions to be encountered should be defined within the trial.

4.2.3 Vehicle specification

Experimental apparatus used to represent the driving task should be described as fully as practicable.

EXAMPLE Make and model of road vehicle employed or driving simulator characteristics.

4.2.4 TICS specification

The characteristics of the TICS should be reported.

EXAMPLE Type, position and image quality of a visual display.

4.2.5 Subject training

Trial objectives will determine the need for subject training in the use of the TICS. Assuming that some form of training is required, subjects should receive clear and consistent guidance. The tasks and subtasks associated with the TICS should be fully explained to the subject and the limitations of responsibility and pacing of these between the driver and experimenter should be specified. Each subject's familiarity with the TICS prior to the trial should be reported. When determining the usability of the TICS device, consideration should be given to the level and assessment of training required.

4.2.6 Data exclusion

Control procedures for individual evaluation trials within an experimental programme should include guidelines for the conditions under which the trial is to be terminated.

EXAMPLE Trial aborted for failure to complete a task or subtask: how this is to be recorded or how the trial is to be re-scheduled.

4.2.7 Experimental conditions, tasks and subtasks

4.2.7.1 Experimental condition

This is considered to encompass all visual behaviour of the driver during an experimental session.

EXAMPLE The distributions of visual scanning to all specified targets of the visual scene (including the TICS), from the specified start of a test route to its specified end.

4.2.7.2 Task

This is the driver's visual behaviour associated with a target.

EXAMPLE All visual behaviour associated with the use of a route guidance system.

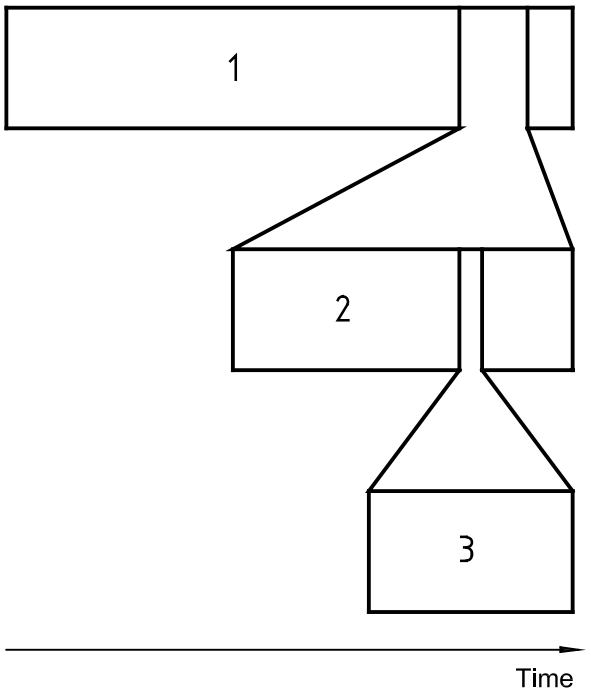
4.2.7.3 Subtask

This refers to one specific interaction with a target

EXAMPLE When using a route guidance TICS, determining the next turning manoeuvre required.

4.2.7.4 Relationship

The relationship between an experimental condition, a task and a subtask is graphically represented in Figure 1.



Key

1 Experimental condition
2 Task
3 Subtask

Figure 1 — Experimental condition, task and subtask — Relationship

5 Recording equipment

5.1 General

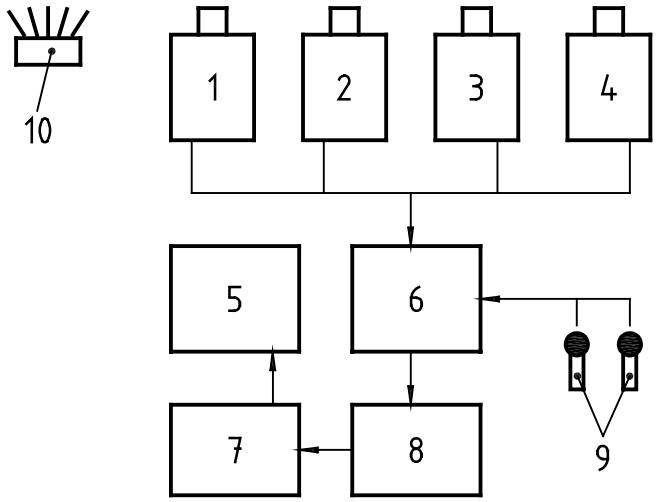
The following gives practical advice on the use of data recording equipment to monitor driver visual demand.

5.2 Reference procedure

A reference procedure for the collection of driver visual behaviour is defined using commonly available video camera and recording/playback equipment. It is acknowledged that more complex equipment can be utilized in such evaluations, but for the purposes of TICS evaluation, video-based recording equipment is considered a minimum. These guidelines describe considerations related to the use of video recording techniques and their subsequent analysis, and are intended to be feasible and effective when applied both within simulated driving environments and to real-world trials for determining the visual demand of TICS.

5.3 Equipment

Figure 2 shows the components constituting a typical data-capture system for visual allocation data-gathering using video recording equipment.



Key

1	Gaze camera	6	Video mixer
2	Vehicle controls	7	VCR
3	Lane position	8	Time generator
4	Forward view	9	Microphones
5	Monitor	10	IR light source (night runs only)

NOTE Cameras are oriented to the driver's face, the road scene ahead, the position in lane and the in-vehicle controls.

Figure 2 — Schematic view of typical data-capture system

5.4 Camera positioning

At least one camera needs to be mounted so that it can be directed toward the driver’s face. This view is required to record the driver’s visual glances during data collection. It is important to position the camera and its mount in such a location that their presence does not affect the driver’s view of the driving scene or any in-vehicle control or display. The addition of other cameras will be beneficial for capturing more information-related events inside and outside the vehicle. It is advisable to employ cameras that are as small and unobtrusive as is practicable.

5.5 Video recording system

When using a VCR as the recording system, high-quality video tape should be used for good resolution. The recording system should be set to run at the fastest recording speed for best picture resolution.

A video monitor is needed for examining the quality of the recorded image. Ideally, such a monitor should be positioned such that the experimenter is able to observe the recorded data periodically during an experimental condition.

A calibration video needs to be made wherein the driver is asked to systematically look to the pre-specified regions of the visual scene. Periodically, a recalibration video should be made to aid in the data reduction.

A labelling system is needed that superimposes time information on the recorded image. The device should provide a high-resolution time or frame code.

It is advisable to have additional cameras for capturing the road scene ahead and in-vehicle activities. Where this is the case, it is recommended that video mixing equipment be used to combine all camera images onto a single time-coded videotape.

Microphones can be readily interfaced into the video data-capture system and audio recordings can be made. This option should be considered for capturing any verbal protocols from the experimenter or subject. Auditory event markers may also be recorded to facilitate cueing during data reduction.

5.6 Installation

Although the specific conditions of an experiment will vary, the following general principles should be applied.

The data collection system fitted and procedures employed should not obscure the driver's view of the roadway or any in-vehicle equipment, and should not cause the driver any unnecessary distraction.

These criteria also apply to any experimenters who may be present within the test vehicle.

5.7 Data reduction

5.7.1 General

The translation of experimental records of visual behaviour such as videotape into metrics of visual demand requires that several assumptions be made. Guidance on the suggested steps to be performed in data analysis following a practical TICS evaluation are given in the following.

5.7.2 Sample interval

Two regimes may be adopted in the transcription of videotape records:

— transcription of the entire experimental session, for all identified regions of the visual scene;

— transcription of the forward view and other region-of-interest pairs (e.g. TICS display).

The data analyst should be trained to carry out the following steps for the manual transcription of driver behaviour video records.

a) Advance the videotape to the start of a sample interval (experimental condition, task or subtask) of interest.

b) Examine the first frame of the driver's face to determine the glance location, then transcribe this as the target region applicable and the starting time for that glance.

c) Advance the videotape frame-by-frame until the driver's eyes move to another specified target. When this occurs, transcribe the new target and the time code for that frame.

d) Repeat the previous steps frame-by-frame until the sample interval has been fully transcribed.

An example of a transcription record is given in Table 1.

Table 1 — Example transcription record

Clock time	Driver mirror	Right region	Left region	Into car	Notes
54:51:31	0,6				
54:52:44		0,5			
54:56:22	0,8				
etc.				1,5	Looks at the instruments.

5.7.3 Summary data

Data that summarizes the trial, encompassing the information as given in Tables 2 to 5, should be reported.

Table 2 — Subject summary information

Parameter	Information required
Age	Range, mean and standard deviation
Sex	Number of each sex
Distance (kilometres or miles/year during the previous five years)	Range, mean and standard deviation
Years of driving	Range, mean and standard deviation
Visual legal compliance	Statement that all subjects comply with relevant legal requirements for minimum driving visual ability
Visual ability	Definition of range of subjects visual ability relevant to the experimental design
Exclusion criterion	Description and frequency of exclusions

Table 3 — Experimental design summary information

Parameter	Information required
Experimental conditions	Number and description
Factors	Number and description
Duration of condition	Range, mean and standard deviation
Independent variables	Number and description
Dependent variables	Number and description
Vehicle environment	Public road, test track or simulator
Type of roadway	Urban, rural, motorway
Traffic density	Definition and report of low, medium or high density
Exclusion criterion	Description and frequency of exclusions

Table 4 — TICS and control condition summary information

Parameter	Information required
System	Description of system including functions, controls and displays
Tasks	Number and description
Subtasks per task	Number and description
Task and subtask pacing	Frequency and description
Subject experience of TICS	Categorization of experience
Exclusion criterion	Description and frequency of exclusions

Table 5 — Visual data classification summary information

Parameter	Information required
Number of regions	Number and boundaries (forward view, driver mirror etc.)
Calibration of target regions with respect to driver's glances	Statement that all subjects instructed to fixate on each target region prior to experimental condition, including relevant subject instructions
Start of experimental conditions, tasks and subtasks	Time (and definition of environmental cue if any)
Stop of experimental conditions, tasks and subtasks	Time (and definition of environmental cue if any)
Basic unit of observation for data reduction	Data recording resolution
Exclusion criterion	Description and frequency of exclusions

6 Data analysis and presentation

6.1 General

It is possible to determine fundamental measures (as defined in ISO 15007-1) from transcribed video records for each specified region.

Fundamental measures associated with a target (e.g. a display or control location) include dwell time, transition time, glance duration and glance frequency. From these, a number of derived measures of visual behaviour have been defined and interpreted from the standpoint of visual demand.

Likely glance targets of interest may include the

— road scene ahead,

— left-side-view mirror (and/or window),

— right-side-view mirror (and/or window),

— centre-rear-view mirror,

— TICS display(s), and

— instrument panel, which may be further subdivided (radio, air-conditioning, speedometer, etc.).

6.2 Validity

Issues specific to the experimental work which may limit the validity of findings should be reported. For example, distributions of visual scanning during day and night driving may be different. Criteria for exclusion of data, such as non-relevant driver behaviour or non-relevant vehicle behaviour or equipment malfunction, should be carefully defined and documented in the report of driver visual behaviour.

6.3 Interpretation of visual demand measures

6.3.1 Key measures

Key measures that should be considered for visual demand assessment include total glance time and proportion of total glance time in relation to the following key locations:

— on-road;

— on-mirror;

— in-vehicle (i.e. to a TICS device).

Example interpretations of some of the commonly applied visual demand measures follow.

6.3.2 Glance frequency and duration

Glance frequency and glance duration may be traded off within a fixed sample interval. That is, very long glance durations (indicative of high workload demand) may be associated with fewer rather than more glances. Thus it is important to consider the two measures together, especially if the sample interval is fixed rather than allowed to reflect task completion time.

6.3.3 Time off road-scene-ahead

Time off road-scene-ahead may be considered as the sum of glance durations, over a sample interval, for glances to all targets other than the road scene ahead. It should be noted that the road scene ahead excludes driver's rear-view mirror glances.

6.3.4 Total glance time to a target

Total glance time (or percentage of time) associated with a target (e.g. in-vehicle device) provides a measure of the visual demand posed by that location.

6.3.5 Total glance time as a percentage

Total glance time expressed as a percentage measure may be used when there is a need to normalize total time measures based on the length of the sample interval. As visual demand increases, total time and percentage time should increase.

6.3.6 Transition times

A transition time is roughly a linear function of the distance from one target to another. During the transition time, there is relatively little new visual information available to the driver. Thus increased transition times reflect reduced availability for driver information-gathering.

6.3.7 Fixation probabilities

Fixation probability on a given target reflects the relative attentional demand associated with that target. Across a mutually exclusive and exhaustive set of targets, fixation probabilities capture where the eyes were fixated throughout a sample interval. Given such a distribution, visual demand assessment might statistically compare two such distributions (under two experimental conditions or tasks).

EXAMPLE If device use were to induce a relative decrease in the fixation probabilities associated with the driving scene, such as road scene or rear-view mirrors, this would be considered indicative of the visual demand associated with the device.

6.3.8 Link value probabilities

Link value probabilities represent the relative number of transitions between one target and another and thus the strength of their relationship. The greater the link value probability, the stronger the need to time share attention between the two locations. In visual demand assessment, the link value probabilities may be analysed to assess how visual attention has been affected by TICS use or the driving conditions.

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