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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

DRAFT INTERNATIONAL STANDARD

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

Véhicules routiers — Mesurage et analyse du comportement visuel du conducteur en relation avec les systèmes de commande et d'information du transport

ICS: 13.180; 43.040.15

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 39, *Ergonomics*.

This second edition cancels and replaces the first editions ISO 15007-1 and ISO/TS 15007-2, which has been technically revised.

The main changes compared to the previous edition are as follows:

— xxx xxxxxxxx xxx xxx

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document supports the quantification and description of visual behaviour while using TICS (Transport Information and Control Systems) and driving vehicles in different driving levels of automation. It supports the quantification of information acquisition related to internal and vehicle external environment/objects (e.g. vehicles, billboards, information displays, Variable Message Signs).

It gives help in the assessment of driver state considering visual attention. This document is not addressing fatigue and drowsiness.

The standard describes the phases of visual behaviour assessment including the following steps:

- Calibration setup and calibration verification (piloting phase);
- Data collection;
- Data reduction;
- Quality assessment;
- Data presentation.

Each of these steps has to be handled with care, documented and checked for quality before moving to the next step.

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

1 Scope

This document defines key terms and parameters applied in the analysis of driver visual behaviour focused on glance and glance-related measures. It gives guidelines and minimum requirements on equipment and procedures for analysing driver visual behaviour including assessment of TICS to

- plan evaluation trials;
- specify (and install) data capture equipment; and
- validate, analyse, interpret and report visual-behaviour metrics (standards of measurement).

The parameters and definitions described below provide a common source of reference for driver visual behaviour data.

It is applicable to on-road trials (e.g. field operational tests or naturalistic studies), and laboratory based driving studies. The procedures described in this standard could also apply to more general assessments of driver visual behaviour. Data collected and analysed according to this document will allow comparisons to be performed across different TICS applications and experimental scenarios.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1 Medical terms

3.1.1

area of interest

AOI

pre-determined area within the visual scene, e.g. a rear-view mirror

Note 1 to entry: An AOI will be no smaller than the normal resolution of the eye-measurement system being used (e.g. no smaller than 0.5 ° for typical eye tracking systems). See [E1](#).

3.1.2

blink

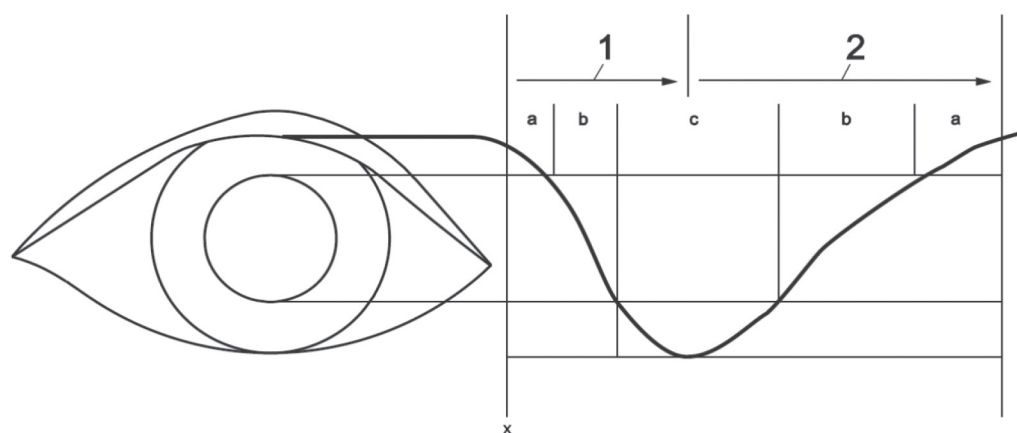
short moment in which the eye is closed by the eyelid

Note 1 to entry: The blink starts when the eyelid starts moving downwards and ends when the eye is fully opened again.

Note 2 to entry: According to the duration for which the eye is closed the following classification applies (see Reference [8]):

- Normal blinks: ≤ 300 ms (mean duration 257 ms; standard deviation 11 ms)
- Long closed durations: 300 ms to 500 ms
- Eye-lid closures: ≥ 500 ms (indicating microsleeps)

Note 3 to entry: Depending on participant state and/or glance direction of a participant the eyelid may not fully open, although the blink might end. Especially in these cases the visibility of the pupil or major part of the pupil is important for correct gaze recognition.



Key

- 1 closing phase
- 2 opening phase
- a open
- b partially closed
- c closed
- x vertical positioning of upper eyelid

Figure 1 — Phases of a blink (see Reference [11])

Note 4 to entry: A blink is performed by the down movements the upper eye lid while lower eyelid remains static. Upper eyelid movement is considered in defining a blink.

3.1.3

direction of gaze

orientation of the eye to the Area of interest (AOI) to which the eyes are directed to

3.1.4 fixation

short temporal holds of movements that keeps alignment of the eyes to particular point within an AOI which falls on the fovea (the middle of the retina responsible for our central, sharpest vision) for a given time period

Note 1 to entry: Typically, individual fixations last from 100 ms to 2 000 ms (see Reference [3]). Fixations are the briefest of pauses during which visual information extraction is done by the eyes-and-brain from spatial areas that fall on the fovea of the eye (and hence are quite small). During fixation, there are believed to be at least three processes taking place (see Reference [10]): 1) analysis of the image falling on the fovea, 2) selection of a new saccade target and 3) programming of the saccade to-be-made-next. It is not yet known how these processes are synchronized by the brain, nor how precisely they are synchronized – since fixation durations are not always long enough to comprehend completion of all the processes. (Sometimes the eyes move before information extraction from the site of fixation has been completed, as evidenced by frequent corrective return fixations to a site under some conditions that was fixated too briefly). There is evidence that the brain both pre-programs fixation duration, and also does “process-monitoring” during a fixation to determine if analysis of the foveal image is complete within the fixation’s duration.before moving on. Thus, fixation time is dependent on both the immediate stimulus and the history of prior fixations. The contribution of both components suggests that fixation time may depend on the task and the amount of useful information in the fixated display (or viewed information) (see Reference [4]).

See E.1 to E.4.

3.1.5 fly through (artfactual fixation)

small ‘snapshot’ of a saccade (< 120 ms) that may be an artefact captured when the eye is moving from one Area of Interest to another Area of Interest, and passing through one or more intermediate Areas of Interest in between

EXAMPLE The eye moves from the road scene ahead to the instrument cluster and passes the head-up display.

Note 1 to entry: Sometimes a small ‘snapshot’ of such a saccade may appear to be a short fixation, when it is really still part of the saccade. Such fly throughs (< 120 ms) are not treated as fixations. Fly throughs may be grouped with the saccade they are part of, if saccades are being measured.

Note 2 to entry: Research shows that fixations can’t be shorter than 100 ms (see Reference [6]).

3.1.6 glance

temporal maintaining of visual gaze within an AOI, bounded by the perimeter of the AOI and may be comprised of more than one fixation and saccades within the AOI and its duration is measured as “glance duration”

Note 1 to entry: A glance is a scientific *construct* that sums over one or more fixations that are made contiguously within a given area of interest (but one that is larger than the area corresponding to the eye’s foveal region – an area that usually requires more than one fixation to view). The construct of a glance, therefore, typically comprehends more than a single fixation and is a coarser unit of analysis than a single fixation (since it is summing over fixations that are contiguous in time and spatially proximal within an *area of interest* (3.1.1). The construct of a “glance” is needed because often the salient questions in a study relate to the amount of contiguous time spent gazing at a particular area of interest (before the eyes move away from it). (Of course, in some instances, the “glance” construct is also necessary because some measurement approaches are not capable of the fine discriminations needed to identify individual fixations (spatially and temporally) – and can only discriminate at the spatial/temporal granularity of glances. Thus, “glances” are a coarser measure of visual information extraction by the eyes/brain from a continuously viewed but somewhat larger spatial region. Typical glance lengths vary by stimulus and task, but might (for example) range from 500 ms to 3 s for a task like “tuning the radio” (see Reference [7]).

See E.1 to E.4.

3.1.7

saccade

brief, fast movement of the eyes that changes the point of fixation, within an AOI or between different AOIs

Note 1 to entry: Saccades reach velocities as high as 500 /s (see Reference [6]), whereby the mean saccade ranges between 1° (text reading) to 5° (scene perception) (see Reference [9]).

See [E.1](#) to [E.4](#).

3.1.8

smooth pursuit movement

smooth, continuous movement of the eyes made to closely follow/pursue a moving object or signal;

Note 1 to entry: Humans generally perform smooth pursuit movements better in the horizontal than vertical dimension, and better in the downward than upward direction. Smooth pursuit movements can have a velocity as high as 90°/s (see Reference [5]).

3.1.9

sample interval

period that constitutes a sample of interest in the data; or, to put it differently, the epoch of time over which measurements are taken

EXAMPLE The duration of an in-vehicle task on entering a destination into a route guidance system, where the evaluation in interest is to evaluate the driver behaviour when the driver performs a task of entering the destination.

Note 1 to entry: Usually, this will be the contiguous epoch of time that is associated with an event or task that is of interest in the study. The sample interval is the period of time (from start to end) during which data are extracted.

3.1.10

transition

change in eye fixation location from one defined area of interest location to a different defined area of interest

Note 1 to entry: A transition could be composed of a large saccade with further head movements to compensate the required total amount of viewing deviation when changing from one AOI to another. E.g. visual task to observe mirror, diverted from the main task while observing the road ahead.

See [E.1](#) and [E.2](#).

3.1.11

visual angle

angle subtended at the eye by a viewed object or separation between viewed objects

Note 1 to entry: The figure below shows the visual angle α .

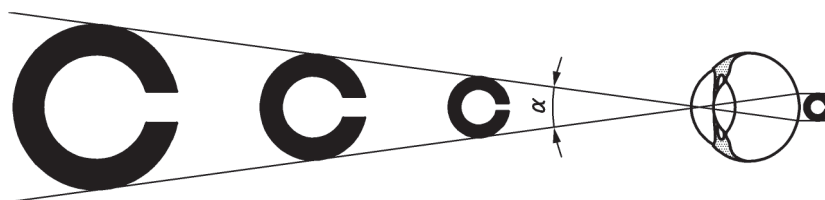


Figure 2 — Visual Angle α

3.1.12

visual demand

degree or quantity of visual activity (determined by e.g. number of glances, total glance time) required to extract information from an object to perform a specific task. See [E.1](#)

3.1.13**visual display**

device used to present visual information. See [F.1](#)

3.2 Terms of metrics**3.2.1 Basic direct metrics****3.2.1.1****duration of diversion**

period of glance duration(s) associated with directions of gaze away from one area of interest to another area of interest during a defined period of interest. See [F.3](#)

3.2.1.2**dwelt time**

sum of consecutive individual fixation and saccade times to an AOI in a single glance. See [F.4](#)

3.2.1.3**glance duration**

time from the moment at which the direction of gaze moves towards an AOI (e.g., the inside rear-view mirror) to the moment it moves away from it

Note 1 to entry: Under certain specific conditions, this may be operationalized differently. See footnote in [F.2](#).

See [F.2](#).

3.2.1.4**minimum glance duration**

shortest possible duration for a fixation to an AOI. The “small fixations” observed to an area of interest of ≤ 120 ms are classified fly through

Note 1 to entry: Fixations to an area of interest ≤ 120 ms are physically not possible. If an eye tracker is in use and records such duration it can be classified as part of a transition between areas of interest and it is not taken into a glance period.

3.2.1.5**scan duration**

time interval consisting of two or more glances that are linked in a consecutive set of fixations to areas of interest in the visual scene

3.2.1.6**transition time**

duration between the end of the last fixation on an AOI and the start of the first fixation on another area of interest

Note 1 to entry: A transition could be composed of a large saccade with further head movement to compensate the required total amount of viewing deviation when changing from one AOI to another. E.g. visual task to observe mirror, diverted from the main task while observing the road ahead.

3.2.2 Glance derived metrics

In this subclause each derived metric is defined, a unit is specified, and an example is provided.

NOTE 1 Examples are illustrative only. Examples do not provide ‘typical’ values, since typical values depend strongly on the task and the AOI. They are meant only to illustrate the use of units.

NOTE 2 Definitions for the terms “road-scene ahead”, “traffic related AOIs” and “non-traffic related AOIs” are given in [Subclause 8.1](#).

3.2.2.1

glance location probability

probability that the eyes are fixated at an AOI (or set of related AOIs) during a condition, task, subtask or sub-subtask

Glance location probability = Number of glances to an AOI during a condition, task, subtask or sub-subtask) / (Number of glances to all AOIs during a condition, task, subtask or sub-subtask) * 100 %;
unit [%]

EXAMPLE 7,85 %.

3.2.2.2

glance rate

number of glances per unit of time

glance rate = (Number of glances)/(duration of condition, task, subtask or sub-subtask); unit [number of glances/s]

EXAMPLE 0,53 glances/s.

Note 1 to entry: To obtain glance rate to a task, only glances to the task would be counted, and divided by the duration of condition, task, subtask or sub-subtask. To obtain glance rate to all locations during a test scenario, all glances to all locations would be counted, and the total divided by the total length of the condition, task, subtask or sub-subtask.

3.2.2.3

link value probability

probability of a glance transition between two different AOIs during a condition, task, subtask or sub-subtask

Link value probability between AOI A and AOI B = (number of glance transitions from A to B + the number of glance transitions from B to A) / (number of glance transitions between all AOIs) * 100 %;
unit [%]

EXAMPLE 17,39 %.

3.2.2.4

maximum glance duration

the longest glance duration to an AOI (or set of related AOIs) during a condition, task, subtask or sub-subtask

Maximum glance duration = max [glance duration1, glance duration2, ..., glance duration n]; unit [s]

EXAMPLE 2,12 s.

3.2.2.5

mean glance duration

mean duration of all glance durations to an AOI (or set of related AOIs) during a condition, task, subtask or sub-subtask

Mean glance duration = (Total Glance Time) / (Number of glances) during a condition, task or subtask; unit [s]

EXAMPLE 1,28 s.

3.2.2.6

number of glances

count of glances to an AOI (or set of related AOIs) during a condition, task, subtask or sub-subtask.
Unit [count]

EXAMPLE 9 glances.

3.2.2.7**percent time on AOI**

ratio representing the percent of time glances are within an AOI (or set of related AOIs) during a condition, task, subtask or sub-subtask

Percent time on AOI = $\Sigma(\text{glance duration1, glance duration2, ..., glance duration n}) / (\text{duration of condition, task, subtask or sub-subtask}) * 100 \%$; unit [%]

EXAMPLE 53,47 %.

3.2.2.8**percentage of eyes off road time****PEORT**

percentage of time during a condition, task, subtask or sub-subtask (i.e., during a sample interval of interest) that glances are not on the road-scene-ahead

Percentage of eyes off road time = $(\text{TEORT}) / (\text{duration of condition, task, subtask or sub-subtask}) * 100 \%$; unit [%]

EXAMPLE 41,29 %.

3.2.2.9**percentage transition time**

percentage of time during a condition, task, subtask or sub-subtask (i.e., during a sample interval of interest) during which the eyes are in transition (or are in movement between areas-of-interest)

Percentage transition time = $\Sigma(\text{transition time 1, transition time 2, ..., transition time n}) / (\text{duration of condition, task, subtask or sub-subtask}) * 100 \%$; unit [%]

EXAMPLE 3,23 %.

3.2.2.10**total eyes off road time****TEORT**

the summation of all glance durations to AOIs other than the road scene ahead during a condition, task, subtask or sub-subtask

TEORT = $\Sigma(\text{glance durations to AOIs defined as off road-scene-ahead})$; unit [s]

EXAMPLE 103,32 s.

Note 1 to entry: The road scene ahead excludes driver's rear-view mirror glances.

Note 2 to entry: This metric has to be operationalized in an appropriate way for each study – since the concept of “not on the road” may comprehend different AOIs depending upon study objectives. When TEORT is utilized, clearly specify which AOIs are counted on the road-scene ahead and which AOIs are defined as off the road scene ahead.

3.2.2.11**total glance time**

summation of all glance durations to an AOI (or set of related AOIs) during a condition, task, subtask or sub-subtask

Total glance time = $\Sigma(\text{glance duration1, glance duration2, ..., glance duration n})$ unit [s]

EXAMPLE 17,88 s.

4 Trial planning and evaluation

4.1 General

Assessment of driver visual demand can be carried out in relation to many forms of TICS applications and road environments. Consideration should be given to the factors/aspects influencing driver visual behaviour.

4.2 Trial planning

The following aspect given in (4.2.2), (4.2.3), (4.2.4), (4.2.5), and (4.2.6) should be considered.

4.2.1 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 (or study). This may entail defining and documenting the roadway geometry, signals, and surroundings — as well as describing the driving scenarios participants will experience (including speeds of travel, maneuvers, traffic densities, movement of traffic, and so forth).

4.2.2 Vehicle specification

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

EXAMPLE Document the make and model of the road vehicle employed or the driving simulator characteristics employed (including key parameters of the vehicle dynamics model, whether the simulator has a fixed- or moving-base, the breadth of its field of view, etc.).

4.2.3 TICS specification

The characteristics of the TICS should be reported.

EXAMPLE Type, position and image quality of a visual display (resolution, contrast, colour-rendition, reflectivity/glare).

4.2.4 Participant selection

Evaluation trials of TICS applications should use a representative sample from the target population for the specific TICS. This driver sample should be categorized by age, gender, visual ability (including colour vision deficiencies, as well as whether and what type of corrective lenses are required to drive) and driving experience.

4.2.5 Participant training

Trial objectives will determine the need for participant training in the use of the TICS. Assuming that some form of training is required, participants should receive clear and consistent guidance. The tasks and subtasks associated with the TICS should be fully explained to the participant and the limitations of responsibility and pacing of these between the driver and experimenter should be specified. Each participant'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. The procedures for verification of calibration and quality assurance in the [Annex B](#) and [E](#) also give guidance if data have to be excluded.

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

4.3 Steps for data acquisition and data processing

The acquisition and analysis of visual behaviour data is a process including the following process steps as described in [Figure 3](#).



Figure 3 — Process steps of acquisition and analysis of visual behaviour

Each of these steps can suffer from different factors leading to artefacts, insufficient data quality or missing data.

Depending on the data acquisition technology and technical setup this clause describes procedures and metrics to check the quality of data and engage countermeasures.

The procedures can be grouped into the following categories:

- Preparation of participant individually.
- Check of technical availability of tracking equipment.
- Check of tracking accuracy of tracking setup.
- Check for quality of manual reduction.
- Check for quality of automated reduction.

While a representative sample of participants is necessary to generalize results, some preparations can have a significant benefit when collecting data with an eye tracker by minimizing extraneous factors not related to the study. In some cases the appearance of the participants might negatively affect the quality of the eye tracking data (e.g., makeup, hair position, eye glasses, amongst others). For example, it might be necessary to ask participants beforehand to wear correction contacts lens, avoid use of fake color contact lens or have them tie back long hair to improve the eye tracking quality.

4.4 Experimental conditions, tasks, subtasks, sub-subtasks, and relationship

4.4.1 ?

4.4.1.1 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 AOIs of the visual scene (including the TICS), from the specified start of a test route to its specified purpose.

Experimenters will need the flexibility to define experimental conditions that are relevant for their research goals. However, when studies involve examining glance patterns for secondary tasks while

driving, the following experimental conditions may be useful for planning and for performing the research. The following terms are introduced because they define intervals of time and behaviour that may be of particular interest when evaluating a TICS – and, hence, in analysing the glance data associated with a TICS.

4.4.1.2 Task

Refers to a sequence of interactions undertaken to achieve a goal. Glance behaviour may be measured over the duration of a task.

Definitions of start and end of a task from the Visual-Manual NHTSA Driver Distraction Guidelines (Docket No. NHTSA-2010-0053): “Start state for a task means the pre-defined device state from which testing of a task always begins. This is frequently the “home” screen, default visual display state, or other default driver interface state from which a driver initiates performance of the task (IV.2.j). Start of data collection means the time at which the experimenter tells a test participant “begin” (or, by some means, issues a non-verbal command indicating the same thing). Test participant eye glances and vehicle driving performance are examined only after the start of data collection (IV.2.i). End State for a Testable Task means the pre-defined device state sought by a test participant to achieve the goal of that testable task (IV.2.d). End of Data Collection means the time at which a test participant tells the experimenter “done” (or, by some means, indicates non-verbally the same thing) (IV.2.c).”

EXAMPLE All visual behaviour occurring during the procedure (task) of entering a destination into a route guidance system.

4.4.1.3 Subtask

Refers to a sequence of interactions undertaken to achieve a subgoal of the task (often one specific interaction). Glance behaviour may be measured over this (shorter) duration of the subtask.

EXAMPLE When entering a destination into the route guidance system, all visual behaviour associated with entering the “city name” portion of the destination.

4.4.1.4 Sub-subtask

Refers to operations or interactions with lower-level subtask elements (e.g., individual controls or screens).

EXAMPLE On the route guidance system, glance behaviour associated with the sub-subtask of “verify the city name appeared” on destination entry screen.

EXAMPLE On the route guidance system, entering a single letter of the destination by aligning the finger on to the touch screen of keyboard.

4.4.1.5 Relationship

Refers to the relation between an experimental condition, a task, a subtask and a lower level subtask element; and is graphically represented in [Figure 4](#).

Annotation: Users of this standard may wish to consult references on hierarchical task analysis for guidance on how to decompose a task (e.g., Shepard, A. (2001). Hierarchical Task Analysis. London: Taylor and Francis).