



JOINT CANADA-UNITED STATES
NATIONAL STANDARD

ANSI/CAN/UL 8400:2025

STANDARD FOR SAFETY

Virtual Reality, Augmented Reality and
Mixed Reality Technology Equipment

SCC FOREWORD

National Standard of Canada

A National Standard of Canada is a standard developed by a Standards Council of Canada (SCC) accredited Standards Development Organization, in compliance with requirements and guidance set out by SCC. More information on National Standards of Canada can be found at www.scc.ca.

SCC is a Crown corporation within the portfolio of Innovation, Science and Economic Development (ISED) Canada. With the goal of enhancing Canada's economic competitiveness and social well-being, SCC leads and facilitates the development and use of national and international standards. SCC also coordinates Canadian participation in standards development, and identifies strategies to advance Canadian standardization efforts.

Accreditation services are provided by SCC to various customers, including product certifiers, testing laboratories, and standards development organizations. A list of SCC programs and accredited bodies is publicly available at www.scc.ca.

UL Standard for Safety for Virtual Reality, Augmented Reality and Mixed Reality Technology Equipment,
ANSI/CAN/UL 8400

First Edition, Dated April 28, 2023

Summary of Topics

This revision of ANSI/CAN/UL 8400 dated January 17, 2025 includes the following changes in requirements:

- **Revision of Age requirements:** [12.3.2.1](#)
- **Revisions per UL 62368-1 and revision of Functional Safety requirements:** [4.3](#), [Table 1A](#), [4.3A](#), [4.3B](#), [4.4](#), [Table 2](#), [Clause 8](#), [10.3](#), [Table 3](#), and [Clause 13](#)
- **Revision of Skin Compatibility requirements:** [Clause 7](#), [12.2.4](#), [E.1](#), [E.2](#), and [Annex I](#)
- **Revision of Biomechanical Stress requirements:** [9.1](#), [9.2](#), [9.3](#), [Figure 1](#), [9.4](#), [Figure 3](#), and [Figure 4](#)
- **Revision of Safety and Warning Instructions:** [12.1](#), [12.2.1](#), [12.3.1](#), [12.4.4](#), and [12.5](#)
- **Clarification of Transmittance testing:** [Clause 5](#), [Annex A](#), [Annex E](#), and [Annex I](#)
- **Clarification of Flicker testing:** [Clause 6](#)
- **Revisions to incorporate UL 4200A, Products Incorporating Button Batteries or Coin Cell Batteries:** [Clause 2](#) and [4.6](#)
- **Revision to scope of the Standard:** [Clause 1](#)
- **Miscellaneous editorial updates:** [3.2.1](#) – [3.2.4](#), [3.3.1](#), [3.3.2](#), [3.3.4](#), [3.3.6](#), [3.5.3](#), [3.5.5](#), [3.5.10](#), [3.5.12](#), [3.5.21](#) – [3.5.25](#), [3.5.29](#) – [3.5.31](#).

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated May 31, 2024 and September 27, 2024.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form by any means, electronic, mechanical photocopying, recording, or otherwise without prior permission of ULSE Inc. (ULSE).

ULSE provides this Standard "as is" without warranty of any kind, either expressed or implied, including but not limited to, the implied warranties of merchantability or fitness for any purpose.

In no event will ULSE be liable for any special, incidental, consequential, indirect or similar damages, including loss of profits, lost savings, loss of data, or any other damages arising out of the use of or the inability to use this Standard, even if ULSE or an authorized ULSE representative has been advised of the possibility of such damage. In no event shall ULSE's liability for any damage ever exceed the price paid for this Standard, regardless of the form of the claim.

Users of the electronic versions of UL's Standards for Safety agree to defend, indemnify, and hold ULSE harmless from and against any loss, expense, liability, damage, claim, or judgment (including reasonable attorney's fees) resulting from any error or deviation introduced while purchaser is storing an electronic Standard on the purchaser's computer system.

APRIL 28, 2023

(Title Page Reprinted: January 17, 2025)

1

ANSI/CAN/UL 8400:2025

**Standard for Virtual Reality, Augmented Reality and Mixed Reality
Technology Equipment**

First Edition

April 28, 2023

This ANSI/CAN/UL Standard for Safety consists of the First Edition including revisions through January 17, 2025.

The most recent designation of ANSI/UL 8400 as an American National Standard (ANSI) occurred on January 17, 2025. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, Preface or SCC Foreword.

This standard has been designated as a National Standard of Canada (NSC) on January 17, 2025.

© 2025 ULSE Inc. All rights reserved.

No Text on This Page

CONTENTS

Preface	7
1 Scope	9
2 Normative references	9
3 Terms, definitions and abbreviations	10
3.1 Abbreviations	11
3.2 General product safety terms.....	12
3.3 Modes of operation	12
3.4 Immersive technology terms.....	14
3.5 Miscellaneous	15
4 General requirements.....	19
4.1 Acceptance of available data	20
4.2 Basic safety requirements	20
4.3 Supplementary safety requirements	20
4.3A Safety analysis.....	21
4.3B Remote patch management	22
4.4 Application of requirements	22
4.5 General environmental test conditions.....	22
4.6 Products and accessories incorporating button batteries or coin cell batteries	22
5 See-through visual functions	23
5.1 Risk assessment	23
5.2 Measurements	24
5.3 Limits.....	24
5.4 Instructional safeguards	24
6 Flicker	24
6.1 Flicker assessment.....	25
6.2 Light measuring device	25
7 Biocompatibility	25
7.1 Skin compatibility.....	25
7.2 Long term exposure assessment	25
8 Exposure of eyes to thermal energy.....	26
8.1 Ocular surface temperature test.....	26
9 Biomechanical stress	27
9.1 General	27
9.2 Requirements.....	27
9.3 Anthropometric distance measurement.....	27
9.4 Neck extension moment test.....	29
10 Mechanical robustness	30
10.1 Static load test.....	30
10.2 Ball impact test.....	31
10.3 Loaded head impact	31
11 Enhancing spatial perception.....	32
11.1 NST HMD.....	33
11.2 VST HMD.....	33
11.3 OST HMD	34
12 Safety and warning instructions	34
12.1 Warning design	34
12.2 Warning statements	34
12.3 Vulnerable age groups	35
12.4 Mediums for conveying safety and warning instructions	36
12.5 Warning against possible sensory motor adaptation.....	37
13 Functional safety	37

Annex A (normative) Measuring spectrophotometric properties

A.1	General	38
A.2	Calculations of luminous transmittance	38
A.3	Calculations of spectral transmittance	39
A.4	Calculation of relative visual attenuation quotient	40

Annex B (normative) Methods for Assessing Risks of Collision Hazards

B.1	General	46
B.2	NST HMD with total optical occlusion	46
B.3	VST HMD with video pass through cameras	46
B.4	OST HMD with see-through optics	47

Annex C (informative) General Safety Requirements

C.1	General	48
-----	---------------	----

Annex D (informative) Visually Induced Motion Sickness

D.1	General	49
D.2	MtP latency	49
D.2.1	Test Setup	50
D.2.2	FOV Measurement	50
D.2.3	Light measuring device (LMD)	50
D.2.4	Luminance measurement	51
D.2.5	Test image	51
D.2.6	Test procedure	52
D.3	IPD-IAD fit	54
D.3.1	Validation of IAD	54
D.3.2	Adjustable range of IAD	55
D.3.3	Perpendicular alignment	55
D.3.4	Optical alignment	55
D.4	Motion-induced blur	55
D.4.1	Test pattern	55
D.4.2	Moving-edge spatial profile	57
D.4.3	Conversion from MESP to METP	57
D.4.4	Blur duration (BD)	57
D.5	Rest frame jitter	58
D.5.1	Spatial jitter test	58

Annex E (informative) Methods for assessing risks of skin compatibility

E.1	General	60
E.2	Assessment procedure	60

Annex F (informative) Instructional safeguards for see-through visual functions

Annex G (informative) Safety and Warning Instructions

G.1	General	62
G.2	Known and potential hazard types	62
G.3	Product and use considerations	62

G.4 Considerations for vulnerable age groups 63

G5 Mediums for conveying safety and warning instructions 64

Annex H – Safety Marking Translations (Normative for Canada and Informative for the US)

Annex I (informative) References and Documents

No Text on This Page

Preface

This is the First Edition of ANSI/CAN/UL 8400, Standard for Virtual Reality, Augmented Reality and Mixed Reality Technology Equipment.

ULSE is accredited by the American National Standards Institute (ANSI) and the Standards Council of Canada (SCC) as a Standards Development Organization (SDO).

This Standard has been developed in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization.

This ANSI/CAN/UL 8400 Standard is under continuous maintenance, whereby each revision is approved in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization. In the event that no revisions are issued for a period of four years from the date of publication, action to revise, reaffirm, or withdraw the standard shall be initiated.

Annexes [A](#) and [B](#) are identified as Normative, as such, form mandatory parts of this Standard.

Annexes [C](#), [D](#), [E](#), [F](#), [G](#) and [I](#), identified as Informative, are for information purposes only.

Annex [H](#) is identified as Normative for Canada and Informative for the US. Informative text is for informational purposes only, and Normative text is considered to be mandatory.

In Canada, there are two official languages, English and French. All safety warnings must be in French and English. Attention is drawn to the possibility that some Canadian authorities may require additional markings and/or installation instructions to be in both official languages.

Comments or proposals for revisions on any part of the Standard may be submitted at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at <https://csds.ul.com>.

Our Standards for Safety are copyrighted by ULSE Inc. Neither a printed nor electronic copy of a Standard should be altered in any way. All of our Standards and all copyrights, ownerships, and rights regarding those Standards shall remain the sole and exclusive property of ULSE Inc.

This Edition of the Standard has been formally approved by the Technical Committee (TC) on Virtual Reality, Augmented Reality And Mixed Reality Technology Equipment, TC 8400.

This list represents the TC 8400 membership when the final text in this standard was balloted. Since that time, changes in the membership may have occurred.

TC 8400 Membership

Name	Representing	Interest Category	Region
Armstrong, Jameel	Standards Individuals	Testing & Standards Org.	USA
Blackwell, John	Diamond AGE Technology	General Interest	USA
Chiang, Chi Hsia	UL Solutions	Testing & Standards Org.	Chinese Taipei
Eckert, Ted	Microsoft Corp	Producer	USA
Fields, Jenny	UL Standards & Engagement	TC Chair – Non-voting	USA

TC 8400 Membership Continued on Next Page

TC 8400 Membership Continued

Name	Representing	Interest Category	Region
Harsanyi, Stephen	U.S. Consumer Product Safety Commission	Non-voting member	USA
He, Penglin	China Electronics Standardization Institute	Testing & Standards Org.	China
Hua, Michelle	The AR Alliance	Producer	USA
Jiang, Sura	SGS-CSTC Standards Technical Services Co., Ltd.	Testing & Standards Org.	China
Juliano, Tom	Panasonic	Producer	USA
Kamble, Sudesh	Intertek Testing Services	Testing & Standards Org.	USA
Kinateder, Max	National Research Council of Canada	Government	Canada
Ledgerwood, Scott	National Institute of Standards & Technology	Government	USA
Lewis, Winston	Standards Individuals	Consumer	USA
Mak, Shu Lun	Vocational Training Council	Testing & Standards Org.	China
Marks, Ted	Standards Individuals	General Interest	USA
McAlister, Sean	UL Standards & Engagement	TC Project manager – Non-voting	USA
Montgomery, Stephanie	XR Association	Producer	USA
Movva, Venkata	HTC Vive	Producer	USA
Nallani, Arun Kumar	Apple Inc.	Producer	USA
Orumbaev, Aziz	Google LLC	Producer	USA
Perey, Christine	Perey Research & Consulting	General Interest	Switzerland
Prather, Aaron	ASTM International	Testing & Standards Org.	USA
Rate, Simon	Sony Interactive Entertainment	Producer	USA
Reeves, Jonathan	Magic Leap INC	Producer	USA
Shi, Hongbin	Huawei Technologies CO LTD	Producer	China
Stanney, Kay	Design Interactive INC	Commercial / Industrial Users	USA
Tsudama, Kelly	META	Producer	USA
Wang, Ellen	Stanford University Medical Center	Commercial / Industrial Users	USA
Wang, Rui	Zhejiang University	General Interest	China
Weech, Seamas	VPixx Technologies Inc.	Commercial / Industrial Users	Canada
Wren, Matthew	VRAR Chicago, Inc.	General Interest	USA
Xie, Jun	LENOVO (BEIJING) LTD	Producer	China

International Classification for Standards (ICS): 97.200.99

For information on ULSE Standards, visit <https://www.shopulstandards.com>, call toll free 1-888-853-3503 or email us at ClientService@shopULStandards.com.

This Standard is intended to be used for conformity assessment.

The intended primary application of this standard is stated in its scope. It is important to note that it remains the responsibility of the user of the standard to judge its suitability for this particular application.

CETTE NORME NATIONALE DU CANADA EST DISPONIBLE EN VERSIONS FRANÇAISE ET ANGLAISE

1 Scope

This Standard addresses the safety of electrical and electronic equipment within the field of virtual reality, augmented reality and mixed reality technologies with a rated voltage not exceeding 600 V.

EXAMPLE VR/AR/MR head-mounted displays, holographic displays, AR/MR smart glasses, hand-held VR/AR/MR devices and interactive virtual simulators.

These requirements cover visual opacity, flicker, biocompatibility, heat exposure to the eye, biomechanical stress and optical occlusion.

This Standard does not address the following:

- psychological effects, such as modification of phobias and enhancement or repression of emotions,
- neurological effects on the visual systems, such as modification of stereoscopic vision, and visual acuity, and
- vestibular disturbances, such as nausea and vomiting.

This Standard is intended to supplement the requirements addressing risk of electrical shock, fire, thermal burn, and other general product safety aspects that are already covered by the CAN/CSA-C22.2 No. 62368-1/UL 62368-1 requirements for wearable equipment. Annex [D](#) summarizes these aspects.

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 and in alphabetical order. For dated references, only the edition cited apply. Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition to that code or standard.

ANSI/ISEA Z87.1, *Occupational and educational personal eye and face protection devices*

ANSI Z535.4: 2007, *Product Safety Signs and Labels*

ASTM Method D1415-88, *Standard Test Method for Rubber Property – International Hardness*

CAN/CSA C22.2 E60730-1, *Automatic electrical controls – Part 1: General requirements*

CAN/CSA C22.2 No. 0.8, *Safety functions incorporating electronic technology*

CAN/CSA C22.2 No. 62368-1, *Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements*

CSA Z94.3, *Eye and Face Protectors*

EN 960, *Headforms for use in the testing of protective helmets*

IEC 31010, *Risk management – Risk assessment techniques*

IEC 60812, *Failure modes and effects analysis (FMEA and FMECA)*

IEC 60825-1, *Safety of laser products – Part 1: Equipment classification and requirements*

IEC 61025, *Fault tree analysis (FTA)*

IEC 61508-1, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements*

IEC GUIDE 116, *Guidelines for safety related risk assessment and risk reduction for low voltage equipment*

IEEE 1789, *IEEE Recommended Practices for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers*

ISO 3864-1: 2011, *Graphical symbols – Safety colours and safety signs – Part 1: Design principles for safety signs and safety markings*

ISO 10993-10, *Biological evaluation of medical devices – Part 10: Tests for irritation and skin sensitization*

ISO 11664-1, *Colorimetry, Part 1 CIE standard colorimetric observers*

ISO 11664-1, *Colorimetry, Part 2 CIE standard illuminants*

ISO/IEC Guide 98-3, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement* (GUM:1995)

UL 991, *Tests for safety-related controls employing solid-state devices*

UL 1998, *Software in programmable components*

UL 4200A, *Products incorporating button batteries or coin cell batteries*

UL 5500, *Remote software updates*

UL 60730-1, *Automatic electrical controls – Part 1: General requirements*

UL 62368-1, *Audio/video, information and communication technology equipment – Part 1: Safety requirements*

49 CFR Part 572, *Anthropomorphic test devices (ATD), Subpart B – 50th percentile male* (§§ 572.5 – 572.11)

Regulation (EC) No 1272/2008, *Classification, labelling and packaging of substances and mixtures*

3 Terms, definitions and abbreviations

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

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

– IEC Electropedia (also known as IEV): available at <http://www.electropedia.org/>

– ISO Online Browsing Platform: available at <http://www.iso.org/obp>

3.1 Abbreviations

Abbreviations are summarized alphabetically in [Table 1](#).

Table 1
Abbreviations

AEL	acceptable exposure level
AR	augmented reality
arcmin	arcminute
BD	blur duration
CCD	charge-coupled device
CEL	consumer exposure level
CRT	cathode ray tube
dB	decibel
DUT	device under test
FOV	field of view
FPS	frame per second
HMD	head-mounted display
IAD	interaxial distance
IPD	interpupillary distance
IR	infrared
LCD	liquid crystal display
LMD	light measuring device
MB	megabytes
MESP	moving-edge spatial profile
METP	moving edge temporal profile
min	minute
mm	millimeter
MR	mixed reality
ms	millisecond
MtP	motion-to-photon
nm	nanometer
NOEL	no observable effect level
NST	non-see-through
OST	optical see-through
PSC	prolonged skin contact
RE	real environment
RGB	red, green, and blue
VAC	vergence-accommodation conflict

Table 1 Continued on Next Page

Table 1 Continued

VE	virtual environment
VIMS	visually induced motion sickness
VR	virtual reality
VST	video see-through

3.2 General product safety terms

3.2.1

harm

injury or damage to the health of people, or damage to property.

[©ISO. This material is reproduced from ISO/IEC Guide 51:2014 with permission of the American National Standards Institute (ANSI) on behalf of the International Organization for Standardization. All rights reserved. Modified]

3.2.2

hazard

potential source of harm.

NOTE The term “hazard” can be qualified in order to define the origin of the hazard or the nature of the expected harm (e.g., “electric shock hazard”, “crushing hazard”, “cutting hazard”, “fire hazard”).

[©ISO. This material is reproduced from ISO/IEC Guide 51:2014 with permission of the American National Standards Institute (ANSI) on behalf of the International Organization for Standardization. All rights reserved.]

3.2.3

hazardous event

event that can cause harm.

NOTE A hazardous event can occur over a short period of time or over an extended period of time.

[©ISO. This material is reproduced from ISO/IEC Guide 51:2014 with permission of the American National Standards Institute (ANSI) on behalf of the International Organization for Standardization. All rights reserved.]

3.2.4

hazardous situation

circumstance in which people, property or the environment is/are exposed to one or more hazards.

NOTE The exposure can immediately or over a period of time result in harm.

[©ISO. This material is reproduced from ISO/IEC Guide 51:2014 with permission of the American National Standards Institute (ANSI) on behalf of the International Organization for Standardization. All rights reserved.]

3.3 Modes of operation

3.3.1

intended use

use in accordance with information provided with a product or system, or, in the absence of such information, by generally understood patterns of usage.

[©ISO. This material is reproduced from ISO/IEC Guide 51:2014 with permission of the American National Standards Institute (ANSI) on behalf of the International Organization for Standardization. All rights reserved.]

3.3.2

reasonably foreseeable misuse

use of a product or system in a way not intended by the manufacturer, but which can result from readily predictable human behaviour.

NOTE 1 Readily predictable human behaviour includes the behaviour of all types of users, e.g., the elderly, children and persons with disabilities. For more information, see ISO 10377.

NOTE 2 In the context of consumer safety, the term "reasonably foreseeable use" is increasingly used as a synonym for both "intended use" and "reasonably foreseeable misuse."

[©ISO. This material is reproduced from ISO/IEC Guide 51:2014 with permission of the American National Standards Institute (ANSI) on behalf of the International Organization for Standardization. All rights reserved.]

3.3.3

operating condition

characteristic which may affect performance of a component, device or equipment.

[SOURCE: IEV 151-16-01]

3.3.4

normal operating condition

mode of operating condition that represents as closely as possible the range of intended use that can reasonably be expected.

[©IEC. This material is reproduced from IEC 62368-1 Ed. 3.0 b:2018, with permission of the American National Standards Institute (ANSI) on behalf of the International Electrotechnical Commission. All rights reserved.]

3.3.5

single fault condition

condition in which there is a fault of a single protection (but not a reinforced protection) or of a single component or a device.

NOTE If a single fault condition results in one or more other fault conditions, all are considered as one single fault condition.

[SOURCE: IEV 903-01-15]

3.3.6

abnormal operating condition

temporary operating condition that is not a normal operating condition and is not a single fault condition of the equipment itself.

[©IEC. This material is reproduced from IEC 62368-1 Ed. 3.0 b:2018 with permission of the American National Standards Institute (ANSI) on behalf of the International Electrotechnical Commission. All rights reserved.]

3.3.7

mobile

capable of operating while being moved.

[SOURCE: IEV 151-16-46]

3.4 Immersive technology terms

3.4.1

head-mounted display

HMD

a visual display covering the eyes that is rigidly attached to the head.

3.4.2

virtual environment

VE

an instance of a virtual world presented in an interactive medium such as virtual reality.

NOTE Usually VE and VR are used synonymously, but some authors reserve VE for an artificial environment that the user interacts with.

3.4.3

virtual reality

VR

simulation of the physical presence of the user in a VE that typically occludes the real world and is produced by computer simulation, enabling the human to interact with a three-dimensional, computer generated environment.

NOTE The produced environment can replicate a RE or create an imaginary world.

[SOURCE: IEC 60050-171-09-13, modified]

3.4.4

augmented reality

AR

form of reality in which the virtual content is added on top of non-occluded optical field of view of the real environment.

NOTE Such virtual content may include augmentations.

3.4.5

mixed reality

MR

the merging of real and virtual worlds in which cameras capture the real environment and then those images are modified with virtual information.

3.4.6

cross reality

extended reality

XR

an umbrella term encompassing AR, VR, MR, as well as mixing or blending and everything in between.

3.4.7

optical occlusion

an act of instance of obstructing vision.

NOTE For the purpose of this standard, immersive technologies are classified into three classes by the amount of optical occlusion: NST (non-see-through) VST (video see-through), and OST (optical see-through).

3.4.8

non-see-through**NST**

a system that is subject to full optical occlusion.

NOTE For the purpose of this standard, NST is assumed that the visual stimulus is substituted by that created by computer simulation, in other words, the user is fully immersed in the VE while the real world is blocked out.

3.4.9

video see-through**VST**

a system like NST but capable of streaming the “passthrough” camera feeds on the display which allows the user to get a glimpse of the surroundings.

NOTE For the purpose of this standard, the spatial and temporal resolution of the VST camera feeds is assumed to be inferior than that of vision.

3.4.10

optical see-through**OST**

a system where the image is displayed on the see-through optics through reflection or waveguide that enables optical superposition of digital information onto the direct view of the physical world and optically maintains see-through vision to the real world.

NOTE For the purpose of this standard, OST is assumed that the direct view of the real world is mostly preserved at all times although the FOV may be limited, and the beam of light is neither converged nor diverged (and thus no intended focal power).

3.5 Miscellaneous

3.5.1

visually induced motion sickness**VIMS**

a subcategory of motion sickness that specifically relates to nausea, oculomotor strain, and disorientation from the perception of motion while remaining still and can lead to malaise, postural instability, dysmetria, and visual disturbances.

NOTE VIMS is also known as cybersickness and may occur without vestibular stimuli.

3.5.2

latency

a time interval between the stimulation and response.

NOTE Latency is, from a more general point of view, a time delay between the cause and the effect of some physical change in the system being observed.

3.5.3

motion-to-photon latency**MtP latency**

an end-to-end delay between the motion (e.g., head rotation) and the photon (e.g., at some point the photons are emitted from the image reflecting that movement).

NOTE In the context of VR, an undue amount of MtP latency may cause visual-vestibular conflict and subsequently lead to motion sickness, while in the context of AR/MR, the virtual content may be misregistered into or misaligned with real life features.

3.5.4

refresh rate

the number of times a display screen is redrawn or refreshed each second, in hertz (Hz).

NOTE In contrast with the refresh rate, the frame rate (in FPS) is the number of consecutive full-screen images that are fed to the display each second.

3.5.5

field of view**FOV**

an angle in degrees of the visual field.

NOTE For the purpose of this standard, the extent of vision through the mounted lens in the as-worn position measured with reference to the entrance pupil of the stationary eye when placed on the appropriate headform.

[©ISO. This material is reproduced from ISO 4007:2018 with permission of the American National Standards Institute (ANSI) on behalf of the International Organization for Standardization. All rights reserved.]

3.5.6

luminance

a photometric measure of the luminous intensity per unit area of light travelling in a given direction, in candela per square meter (cd/m^2) or nit.

[SOURCE: IEV 845-01-35]

3.5.7

entrance pupil

the full diameter of the light gathering aperture of an instrument (e.g., the diameter of a lens).

3.5.8

eye point

the location at which the eye should be positioned for optimal viewing with respect to the corresponding displayed image.

3.5.9

360 spherical panoramic picture

a picture has a horizontal FOV of 360 degrees and a vertical FOV of 180 degrees.

3.5.10

interpupillary distance**IPD**

distance between the centres of the pupils when the eyes are fixating an object at an infinite distance in the straight ahead position.

3.5.11

interaxial distance**IAD**

the length between the centres of the lenses.

3.5.12

optical axis

straight line joining the centres of curvature of both surfaces of a lens.

NOTE This line is normal to both optical surfaces so light can pass along it undeviated.

[©ISO. This material is reproduced from ISO 13666:2019 with permission of the American National Standards Institute (ANSI) on behalf of the International Organization for Standardization. All rights reserved ©ISO.]

3.5.13

smooth pursuit

a basic type of eye movements in which the eyes closely track a moving stimulus on the fovea.

NOTE Any depart of the moving object from this smooth motion trajectory is immediately perceived as image blur.

3.5.14

motion-induced blur

a type of motion artifacts due to a smooth pursuit of moving objects at discrete positions in space for an extended period of time, thus violating the assumption of smooth motion trajectory and leading to perceived blur.

NOTE In contrast with CRT phosphors that flash briefly, pixels on an LCD remain lit until the next refresh occurs, in other words, the moving objects will appear stepwise.

3.5.15

moving-edge spatial profile

MESP

a one-dimensional waveform describing the relative luminance (a linear function of luminance) as a function of horizontal position in pixels.

3.5.16

moving edge temporal profile

METP

a convolution of the luminance (gray level) transition with a pulse of duration equal to the hold time (typically one frame).

3.5.17

blur duration

BD

the time between the highest and the lowest relative luminance during gray-to-gray transitions, in ms, as a metric of perceived blur.

3.5.18

rest frame

a frame of reference that remains at rest or moves with constant velocity with respect to others.

3.5.19

jitter

a set of short-term non-cumulative variations in the significant instants of a digital signal from their ideal positions in time.

NOTE By contrast, judder is more of a result of mismatch between the frame rate and the refresh rate.

3.5.20

transmittance

quotient of transmitted radiant flux and incident radiant flux.

NOTE Transmittance can be expressed as a percentage. In this document, it is expressed as a value with a maximum of 1.0.

[SOURCE: IEV 845-24-065]

3.5.21

luminous transmittance

ratio of the luminous flux transmitted to the incident luminous flux for a specified illuminant and photopic vision.

[©ISO. This material is reproduced from ISO 4007:2018 with permission of the American National Standards Institute (ANSI) on behalf of the International Organization for Standardization. All rights reserved.]

3.5.22

spectral transmittance

ratio of the spectral radiant flux transmitted by the material to the incident spectral radiant flux at any specified wavelength, for a specified angle of incidence.

[©ISO. This material is reproduced from ISO 4007:2018 with permission of the American National Standards Institute (ANSI) on behalf of the International Organization for Standardization. All rights reserved.]

3.5.23

relative visual attenuation quotient

quotient of the luminous transmittance of a lens for the spectral radiant power distribution of the light emitted by a traffic signal to the luminous transmittance of the same lens for CIE standard illuminant D65.

[©ISO. This material is reproduced from ISO 4007:2018 with permission of the American National Standards Institute (ANSI) on behalf of the International Organization for Standardization. All rights reserved.]

3.5.24

reference point

points on the lens specified by the manufacturer as the design reference points and at the specified orientation relative to the test instrument's optical axis.

[©ISO. This material is reproduced from ISO 4007:2018 with permission of the American National Standards Institute (ANSI) on behalf of the International Organization for Standardization. All rights reserved.]

3.5.25

boxed centre

intersection of the horizontal centreline and the vertical centreline of the rectangular box that circumscribes the lens shape in its intended orientation.

[©ISO. This material is reproduced from ISO 4007:2018 with permission of the American National Standards Institute (ANSI) on behalf of the International Organization for Standardization. All rights reserved.]

3.5.26

flicker

perception of visual unsteadiness induced by a light stimulus the luminance or spectral distribution of which fluctuates with time, for a static observer in a static environment.

NOTE Flicker is one of detrimental and undesired temporal light artifacts.

[SOURCE: CIE TN 006]

3.5.27

photosensitive seizures

a form of epilepsy in which seizures are triggered by visual stimuli that form patterns in time or space, such as flashing lights; bold, regular patterns; or regular moving patterns.