
**Eye and face protection — Test
methods —**

**Part 4:
Headforms**

*Protection des yeux et du visage — Méthodes d'essai —
Partie 4: Fausses têtes*

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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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 ISO/TC 94, *Personal safety — Personal protective equipment*, Subcommittee SC 6, *Eye and face protection*.

A list of all parts in the ISO 18526 series can be found on the ISO website.

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

The family of documents comprised of the ISO 16321 series, the ISO 18526 series and the ISO 18527 series was developed in response to the worldwide stakeholders' demand for minimum requirements and test methods for eye and face protectors traded internationally. ISO 4007 gives the terms and definitions for all the various product types. The test methods are given in the ISO 18526 series, while the requirements for occupational eye and face protectors are given in the ISO 16321 series. Eye protectors for specific sports are mostly dealt with by the ISO 18527 series. A guidance document, ISO 19734, for the selection, use and maintenance of eye and face protectors is under preparation.

The basic anatomical requirements of the users of eye and face protection are to be considered when selecting an appropriate size of protector for comfortable and functional use. This document provides the anthropometric and biomechanical data required to prepare headforms used for the testing of protectors. The headform dimensions (series 1 and 2) are based on measurements of humans by the USA's National Institute of Occupational Safety and Health (NIOSH), which is part of the Centers for Disease Control and Prevention.

This document provides headform dimensions based on measurements of humans. Further information is given in [Annex A](#) and [Annex B](#), which, together with [Figure 3](#), are reproduced with NIOSH's and the authors' permission. [Figures 2](#) and [3](#) show the headforms that are slightly modified to show better eye detail.

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Eye and face protection — Test methods —

Part 4: Headforms

1 Scope

This document specifies the dimensions and tolerances of the headforms used for the testing of eye and face protectors.

Additional information is given for:

- anthropometric measurement methods;
- anthropometric data for head and face dimensions;
- human test panels.

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.

ISO 4007, *Personal protective equipment — Eye and face protection — Vocabulary*

CSA Z262.6:2014, *Specifications for facially featured headforms*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4007 apply.

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

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

4 Headforms

4.1 Classification of adult headforms

Six different sizes of headforms are used for testing as given in [Table 1](#).

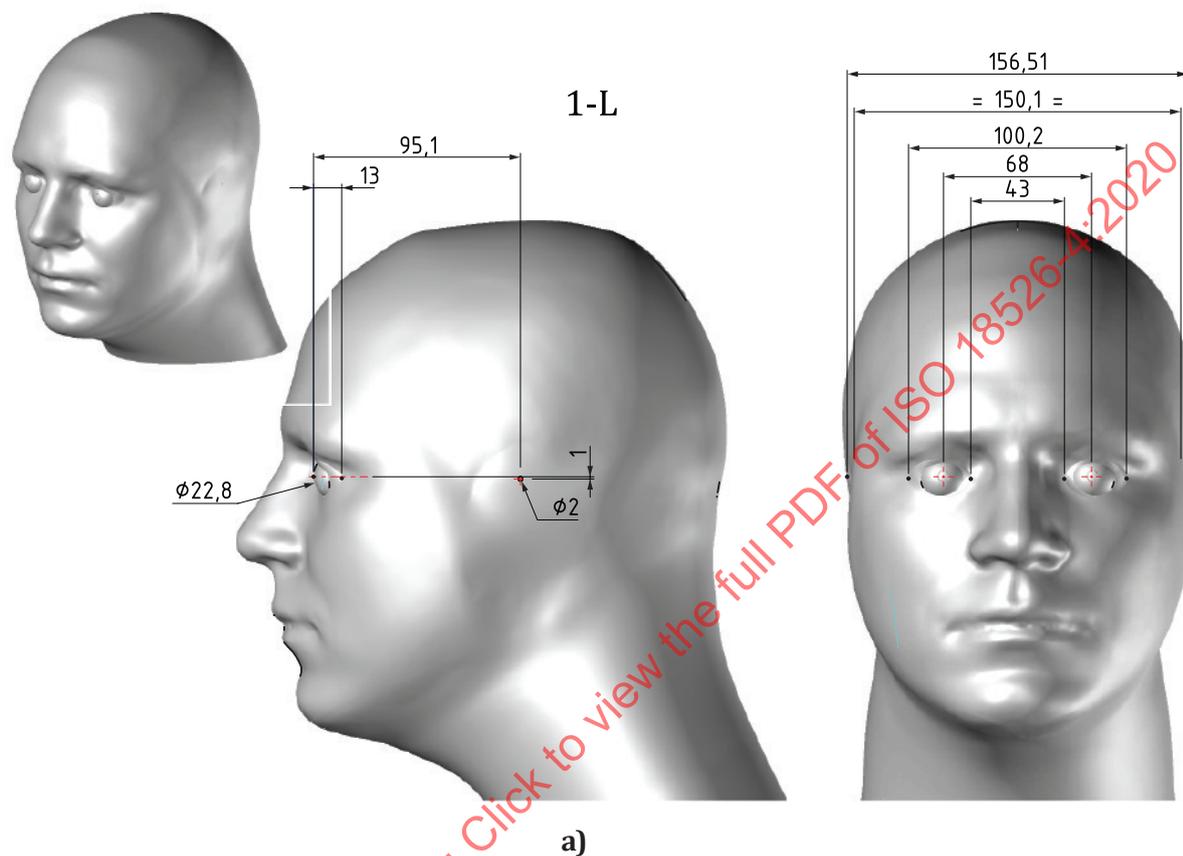
Table 1 — Classification of headforms for eye and face protectors

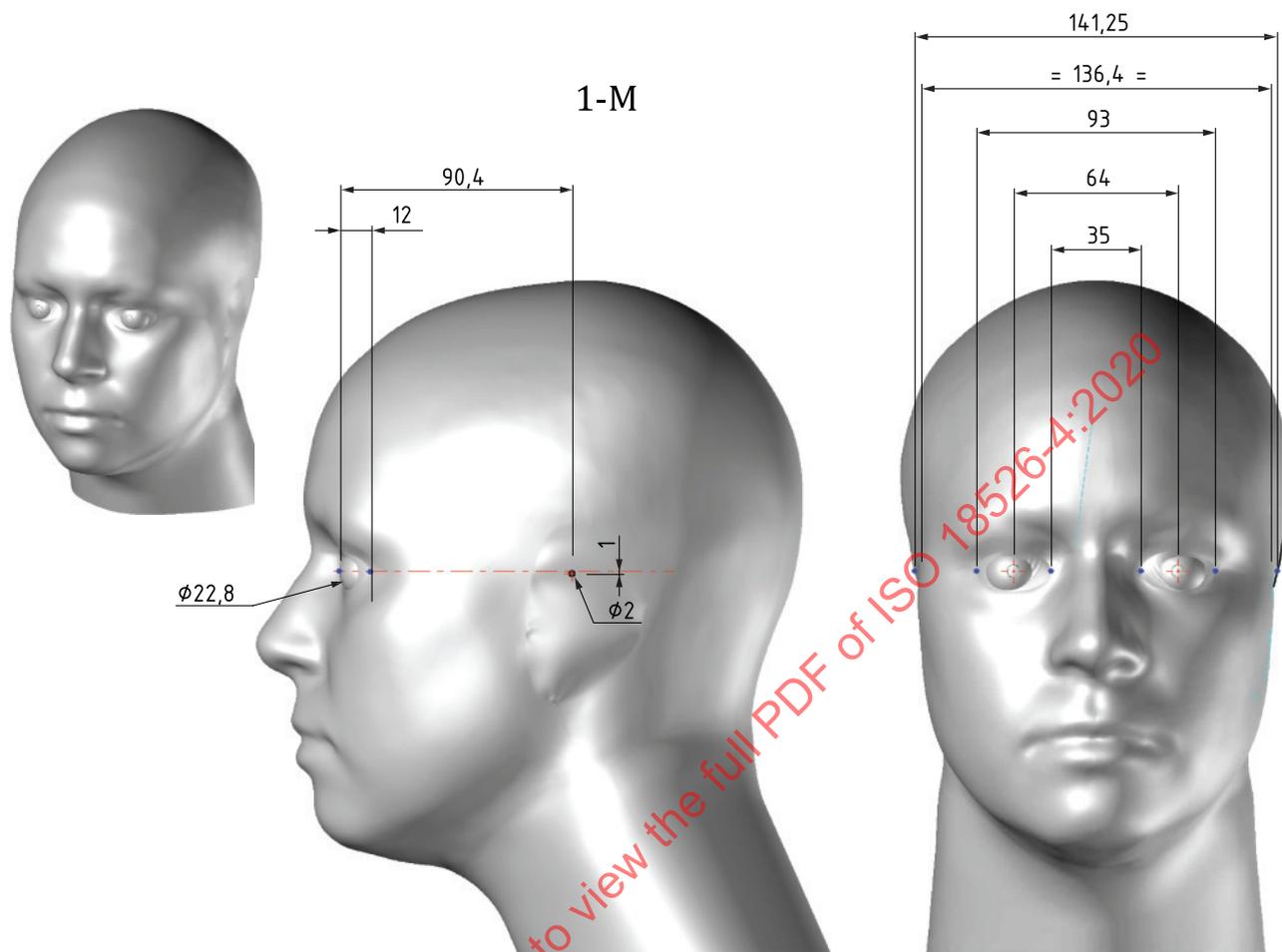
| Small | Medium | Large |
|-------|--------|-------|
| 1-S | 1-M | 1-L |
| 2-S | 2-M | 2-L |

Statistically these six headforms cover approximately 95 % of the population included in this document. [Annex A](#) and [Annex B](#) provide detailed information on the data collection and the human populations

that the data is measured from. The information in [Annex A](#) and [Annex B](#) are from References [2][3][15][16].

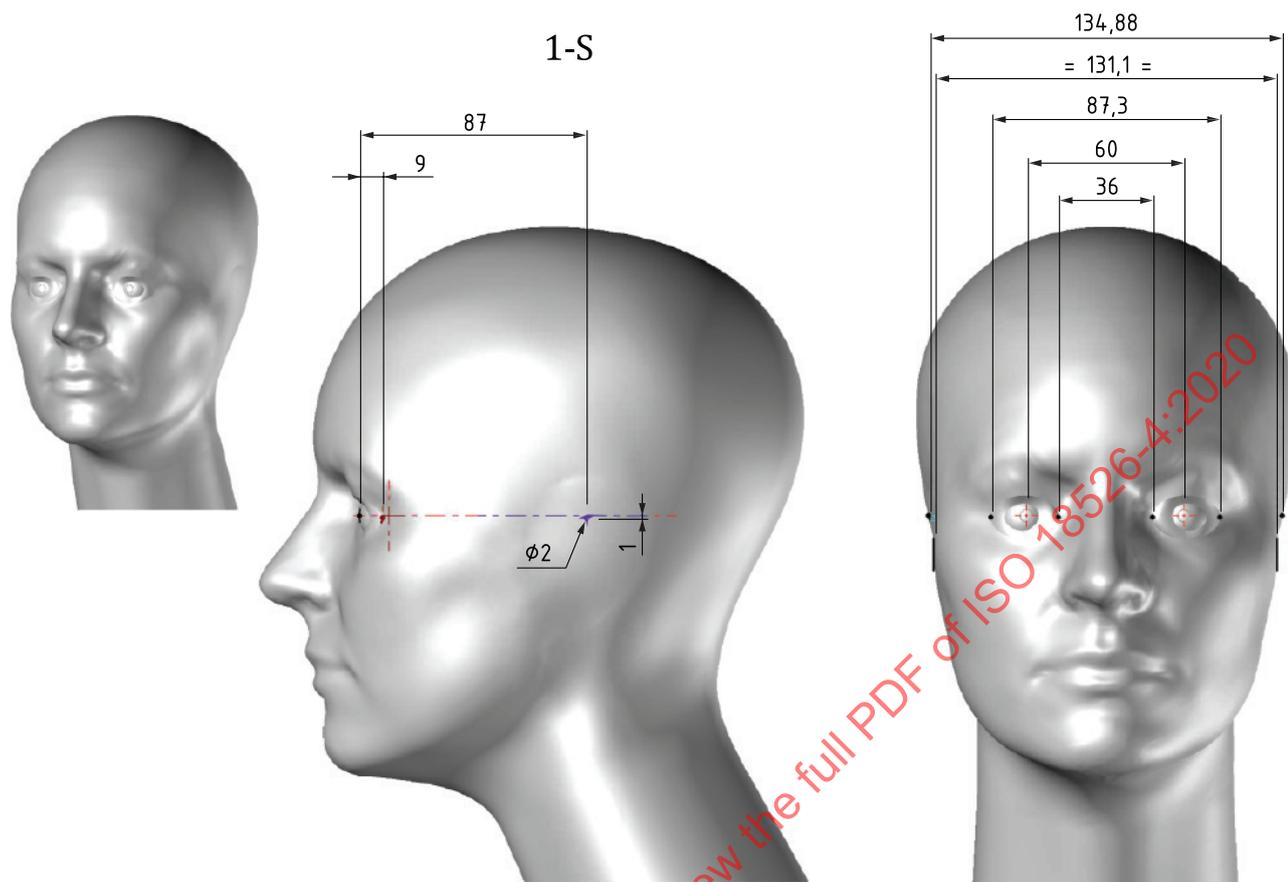
Examples of the headforms are given in [Figures 1](#) and [2](#). The individual figures are not to the same scale as each other, so for accurate details use the CAD files.





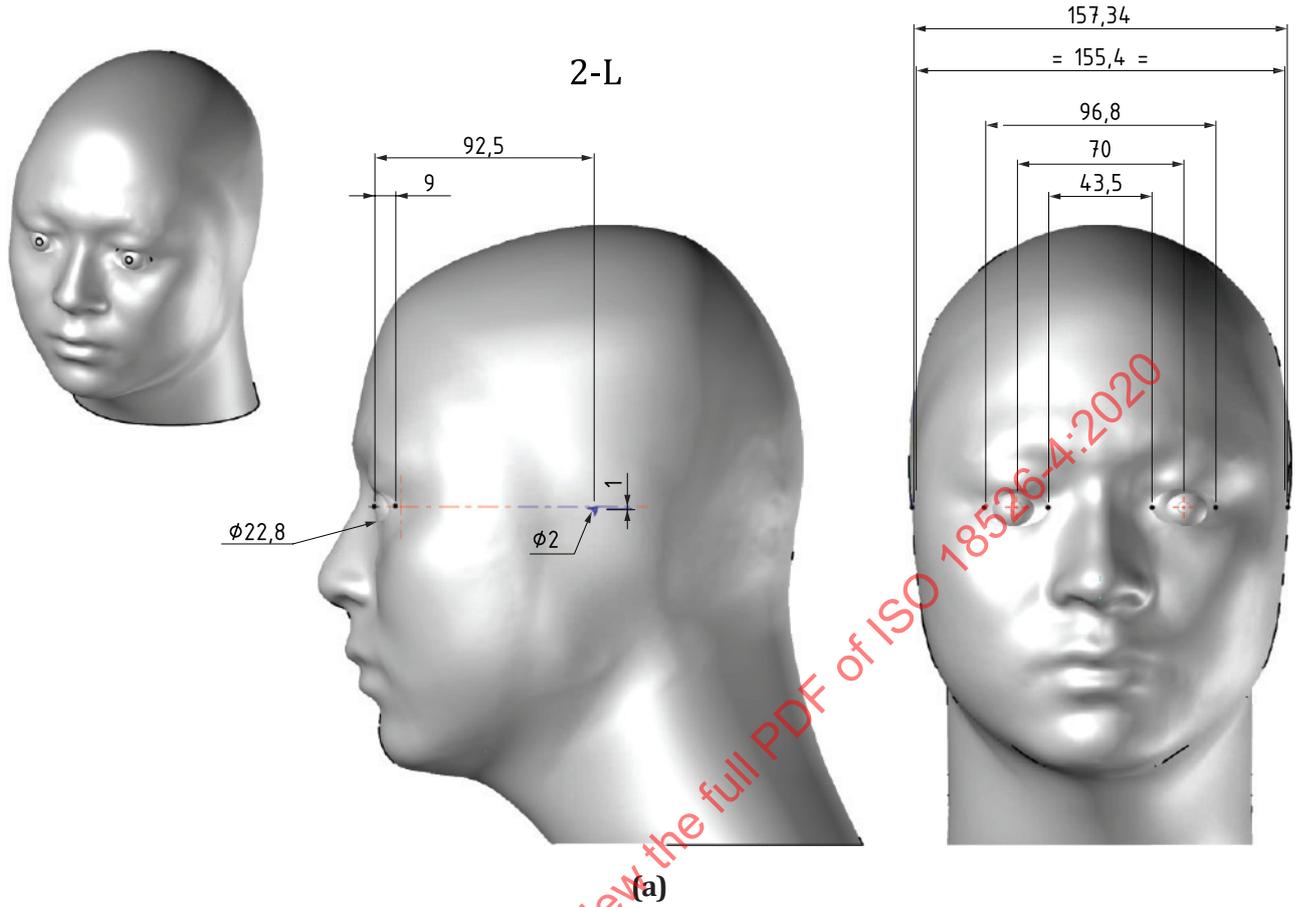
b)

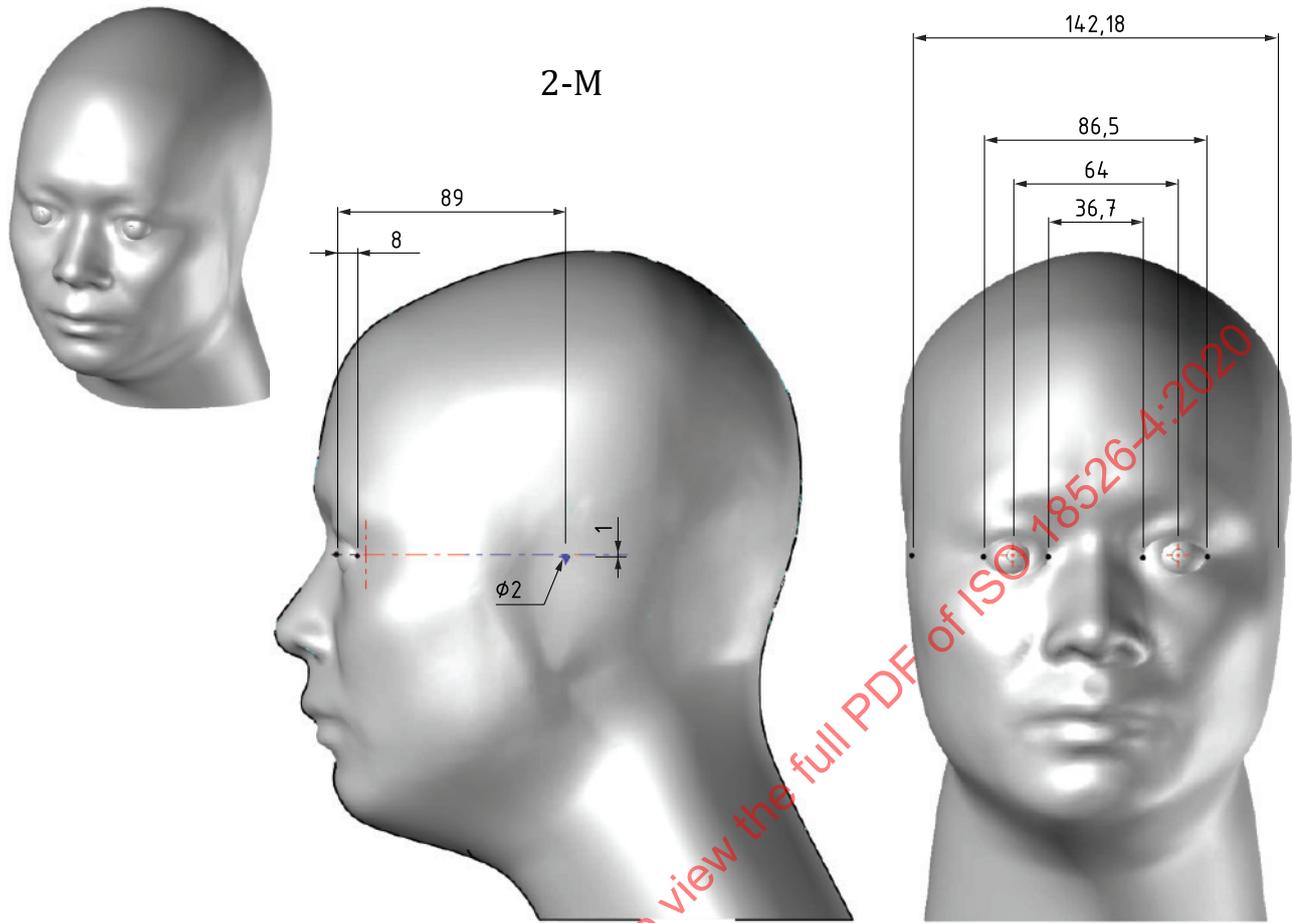
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NOTE Figures are not to scale.

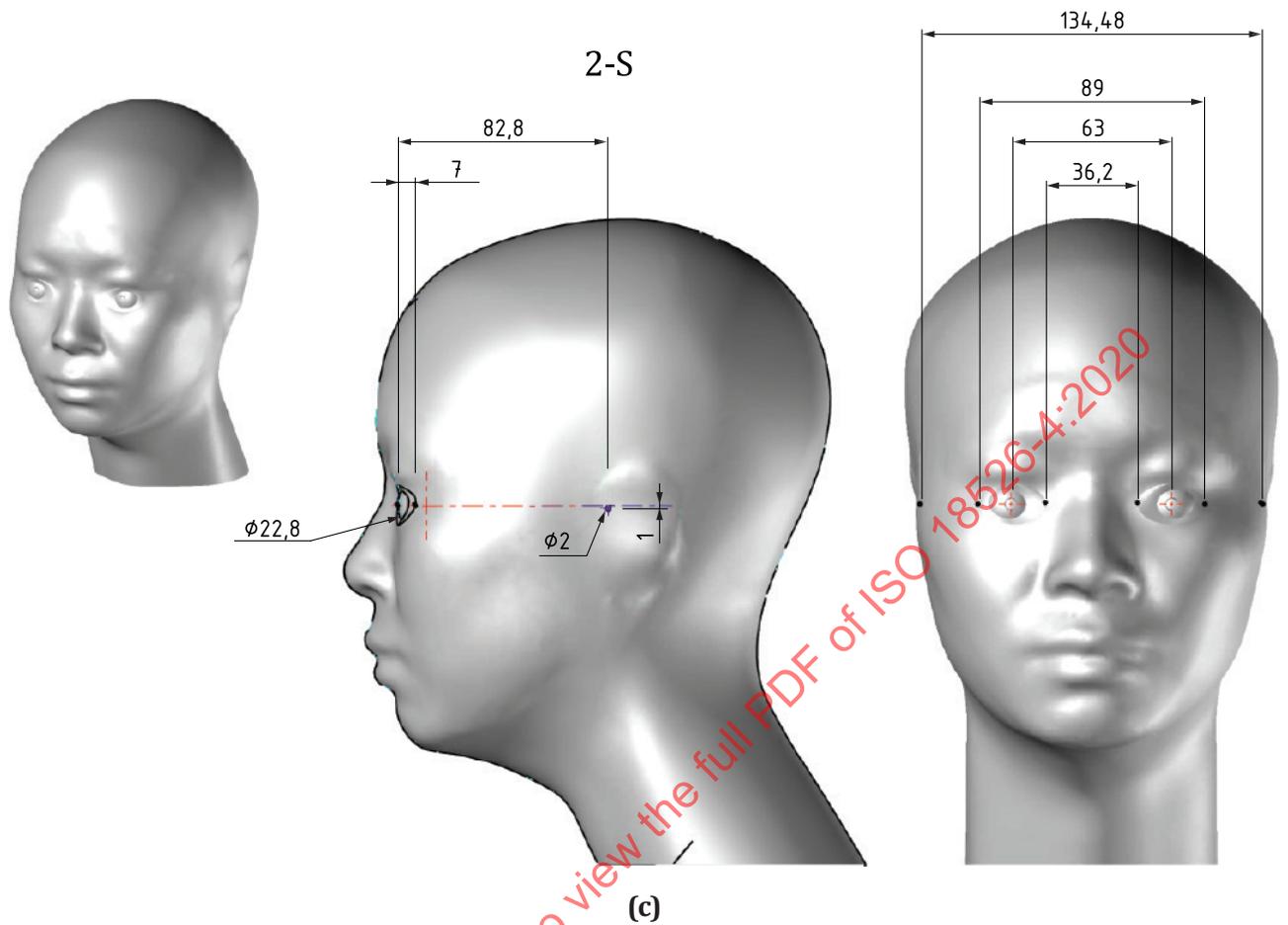
Figure 1 — Examples of 1-L, 1-M, 1-S headforms (front and side view)





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(b)

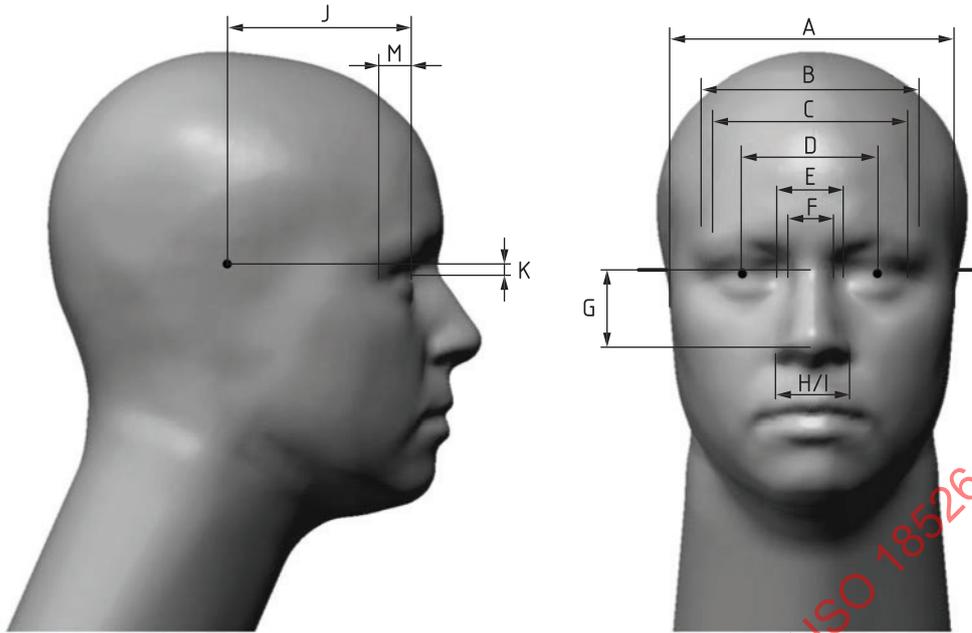


NOTE Figures are not to scale.

Figure 2 — Examples of 2-L, 2-M, 2-S headforms (front and side view)

4.2 Reference distances and dimensions of adult headforms

The reference distances that are needed for the testing of eye and face protectors are given in [Figure 3](#).



NOTE Figures are not to scale, dimensions of the reference distances are given in [Tables 2](#) and [3](#).

Figure 3 — Dimensions and reference distances

The dimensions of the reference distances for the six adult headforms as defined in [Table 1](#) are given in [Tables 2](#) and [3](#) for reference only.

For comparison of dimensions, testing of eye and face protectors and building headforms, the CAD files shall be used. Dimensions in the CAD file are given in millimetres (nominal, unless toleranced) and are available from the International Standards Organisation's website <https://standards.iso.org/iso/18526/-4/ed-1/en>.

The tolerances throughout this document, including [Tables 2](#) and [3](#) shall follow standard engineering drawing practice. All values for [Tables 2](#), [3](#) and those in [Annex B](#) shall be $\pm 0,1$ mm. The tolerances for manufacturers of the headforms are ± 2 % when comparing the manufactured headform measurements to the CAD data.

The dimension “Eye apex to superior attachment of the pinna (Vertical)” has been set to 1,0 mm. This was done to provide a reference plane for the other measurements and causes the headforms to appear to be leaning forward.

The pupil has a diameter of 5 mm, the pinhole for the attachment of the rod locating the ear point 2,0 mm.

Table 2 — Dimensions and reference distances as defined in [Figure 3](#) for the small, medium and large type 1 headforms

| Dimension or reference distance | | Value mm | | |
|---|---|-------------|-------|-------|
| | | 1-S | 1-M | 1-L |
| | Superior attachments of the pinna breadth (not A, but at the ear) | 134,9 | 141,3 | 156,5 |
| A | Bizygomatic Breadth | 131,1 | 136,4 | 150,1 |
| B | Minimum Frontal Breadth | 98,2 | 108,1 | 118,4 |
| NOTE 1 Some of these distances have been rounded to integral values for testing – refer to the appropriate product's requirements standard. | | | | |
| NOTE 2 These dimensions are indicative only – the data in the CAD files are used. | | | | |

Table 2 (continued)

| Dimension or reference distance | | Value mm | | |
|---------------------------------|---|-------------|------|-------|
| | | 1-S | 1-M | 1-L |
| C | Outer Canthal Distance | 87,3 | 93,0 | 100,2 |
| D | Interpupillary Distance (PD) | 60,0 | 64,0 | 68,0 |
| E | Inner Canthal Distance | 36,0 | 35,0 | 43,0 |
| F | Nasal Root Breadth | 17,5 | 18,8 | 20,8 |
| G | Nose Bridge Length | 42,4 | 42,4 | 47,4 |
| H | Anatomical Nose Breadth | 34,8 | 39,0 | 45,4 |
| I | Morphological Nose Breadth | 31,9 | 34,3 | 43,3 |
| J | Corneal Apex to superior attachment of the pinna (Horizontal) | 87,0 | 90,4 | 95,1 |
| K | Corneal Apex to superior attachment of the pinna (Vertical) | 0,0 | 0,0 | 0,0 |
| M | Sagittal distance from corneal apex to lateral canthus (C-D from side view) | 9,0 | 12,0 | 13,0 |

NOTE 1 Some of these distances have been rounded to integral values for testing – refer to the appropriate product's requirements standard.

NOTE 2 These dimensions are indicative only – the data in the CAD files are used.

Table 3 — Dimensions and reference distances as defined in Figure 3 for the small, medium and large type 2 headforms

| Dimensions or reference distances | | Value mm | | |
|-----------------------------------|---|-------------|-------|-------|
| | | 2-S | 2-M | 2-L |
| | Superior attachments of the pinna breadth (not A, but at the ear) | 134,5 | 142,2 | 157,3 |
| A | Bizygomatic Breadth | 134,4 | 142,0 | 155,4 |
| B | Minimum Frontal Breadth | 94,5 | 89,1 | 113,4 |
| C | Outer Canthal Distance | 89,0 | 86,5 | 96,8 |
| D | Interpupillary Distance (PD) | 63,0 | 64,0 | 70,0 |
| E | Inner Canthal Distance | 36,2 | 36,7 | 43,5 |
| F | Nasal Root Breadth | 18,6 | 18,6 | 21,2 |
| G | Nose Bridge Length | 37,9 | 41,0 | 45,0 |
| H | Anatomical Nose Breadth | 36,6 | 40,8 | 40,7 |
| I | Morphological Nose Breadth | 34,6 | 37,6 | 38,7 |
| J | Corneal Apex to superior attachment of the pinna (Horizontal) | 82,8 | 89,0 | 92,5 |
| K | Corneal Apex to superior attachment of the pinna (Vertical) | 0,0 | 0,0 | 0,0 |
| M | Sagittal distance from corneal apex to lateral canthus (C-D from side view) | 7,0 | 8,0 | 9,0 |

NOTE 1 Some of these distances have been rounded to integral values for testing – refer to the appropriate product's requirements standard.

NOTE 2 These dimensions are indicative only – the data in the CAD files are used.

4.3 Classification and dimensions of children headforms

4.3.1 Type1 headforms

If the eye and/or face protector is intended for use by children, the headform sizes 535 and 515 as shown in CSA Z262.6:2014, Figures 3 and 4, shall be used, with the exception that the interpupillary distance, PD, for the size 515 headform shall be 52 mm. For the purposes of this document, size 535 shall be referred to as headform 1-C12 and size 515 as headform 1-C6.

4.3.2 Type 2 headforms

In the absence of standardized headforms 2-C6 and 2-C12, and until such standardized headforms become available, manufacturers designing and testing child-sized protectors for supply to their relevant market may choose other appropriate headforms.

The relevant dimensions of the areas to be protected on the chosen 2-C12 and 2-C6 shall be scaled from those of 1-C12 and 1-C6 in ratio to the PDs, i.e.:

- Dimension for nominated 2-C12 = (Dimension for 1-C12)·(PD for the chosen headform)/58 mm
- Dimension for nominated 2-C6 = (Dimension for 1-C6)·(PD for the chosen headform)/52 mm

For the purposes of third-party testing, the characteristics of the nominated headform shall be communicated to the compliance and test authorities.

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Annex A (informative)

Anthropometric measurements¹⁾

The raw National Institute of Occupational Safety and Health (NIOSH) 3D scan data for 1 169 American workers and 350 Chinese workers were analysed to define the variation of the dimensions that are important to eye and face protectors using 3D processing techniques. Measurements for 317 Japanese workers were also obtained from the National Institute of Advanced Industrial Science and Technology in Japan for comparison purposes. The digital headforms developed for respiratory protective devices and representative of US and Chinese workers, EN 168 small and medium headforms, and two Japanese headforms (one for male and one for female) were compared to determine their representation of the world worker population.

This raw NIOSH dataset was also used for the respiratory headforms given in ISO/TS 16976-2.

The breakdown of this data is:

The American workers in this data are represented by

- 39,3 % Caucasian,
- 36,1 % African American,
- 24,3 % Hispanic,
- 0,3 % Asian, and

In addition, 67 % subjects were male and 33 % were female.

The Chinese data includes 70 % males and 30 % females.

The Japanese data includes 49,2 % males and 50,8 % females.

A further set of data were supplied by AIST in Japan^[13]:

The numbers of the samples that AIST used to make this data of head shapes:

- 52 adult males (ages from 18 to 34),
- 52 adult females (ages from 18 to 34),
- Ethnicity: 100 % Asian (Japanese).

1) See Introduction and [4.1](#).

Annex B (informative)

Anthropometric data for head and face dimensions²⁾

An anthropometric study was conducted by NIOSH in 2003 of the US work Population^[11]. The survey consisted of three age strata (18-29, 30-44, 45-66 years), two gender strata (male and female), and four racial/ethnic group strata (White, African American, Hispanic, and Others). The selected test panel may be seen as representative for the world-wide population, since the US-population is multi-ethnic. Height, weight, 19 face dimensions and neck circumference were measured with traditional methods. A total of 3 997 subjects (2 543 male and 1 454 female) were measured. The sampling strategy called for equal representation in each of the sampling cells. This was done to ensure that we had adequately captured the anthropometric variability in all segments of the population. NIOSH research has resulted in the development of [Table B.2](#).

A set of eleven anthropometric measurements of the head and face were selected to define the dimensions important to eye and face protectors. These measurements are bizygomatic breadth, interpupillary distance, nasal root breadth, minimum frontal breadth, morphological nose breadth, anatomical nose breadth, nose bridge length, inner canthal distance, outer canthal distance, and the vertical and horizontal distances from the apex of the eye to the top of the ear (superior attachment of the pinna) where eye glasses (*spectacles*) would rest. The first five measurements are also used by NIOSH to describe facial dimensions for respiratory protection and therefore were part of the traditional (manual) measurements contained in NIOSH databases. The remaining six dimensions needed to be measured through the use of 3D scans of individuals that have been collected in the past. Two methods were used to ascertain the range of face and head sizes that exist in the population. Method 1 involved the direct measurement (traditional and digital) of individual workers. Method 2 used only digital measurement of 3D models created from the worker databases using 3D processing software. Finally, the measurements were compared to the dimensions of existing headforms used for protective equipment testing.

NIOSH utilized two different methods to populate the databases with the appropriate information.

Method 1

The first approach, Method 1, was to measure the dimensions of individual workers. NIOSH currently has two databases of 3D scans of United States workers containing 1 039 and 227 individuals respectively as well as a database containing the scans of 350 Chinese workers^{[3][15]}. The 1 039 scans of U.S. workers and the 350 scans of Chinese workers were collected using a Cyberware rapid 3-D digitizer (Monterey, CA, USA). The set of 227 scans of U.S workers was collected using a 3dMDcranial5 System (3dMD LLC, Atlanta, Georgia). Measurements of 317 Japanese individuals were obtained from the National Institute of Advanced Industrial Science and Technology (AIST) in Japan. Measurement of U.S. and Chinese workers was done by importing their 3D scans into the IMInspect module of PolyWorks (InnovMetric Software Inc., Quebec, Canada) to manipulate the surface. The Frankfurt³⁾ plane was aligned for each individual to create a reference configuration allowing for consistent measurement of the vertical and horizontal distances from the apex of the eye to the top of the ear (superior attachment of the pinna) where protective eyewear would rest. Using PolyWorks, points were placed at the appropriate landmarks for measuring the six unknown dimensions. Using a basic measurement function, the point to point distances were measured and recorded. The 3D scans of the 1 039 U.S. workers that were collected using the Cyberware scanner did not yield good data for the eye apex to ear measurements due to artifacts from movement during scanning or from hair covering the ears. The 3dMD system gave better data for purposes of this study and therefore the database containing the scans of the 227 workers was also used to represent the U.S. workforce. The first five

2) See Introduction. Copied from [16] but only parts of the tables are reproduced here.

3) See, for example: https://en.wikipedia.org/wiki/Standard_anatomical_position.

measurements were part of our databases and were taken for all 1 266 U.S. workers and 350 Chinese workers. The last six measurements were taken from 75 workers from each of the two U.S. databases and 75 from the Chinese database. The data collected from Japanese workers only included four of the desired measurements. The other measurements could not be made because there was no 3D scan data to work with.

Method 2

A second approach, Method 2, was devised to gather a set of data that would accurately represent all the workers in the database. Using our Shape Analyzer software, two sets of headforms were created to represent U.S. workers and Chinese workers. This was done by combining the 3D data from all available scans to form one head and adjusting the first five principal components^{[10][15]}. Some 3D scans were unusable for this method due to scan defects such as artifacts from movement. From the two U.S. worker databases 945 and 224 scans were usable *giving* a total of 1169. All 350 Chinese worker scans were usable. The first five headforms were created by setting all five principal components to 5 %, 25 %, 50 %, 75 % or 95 %. Next, principal components two through four were set to 50 % and principal component one was set to 5 %, 25 %, 75 % and 95 % yielding four headforms of varying size. This process was repeated for the other four principal components giving 20 headforms of varying sizes. In total, 25 headforms were created from the U.S. database to represent the U.S. workers and 25 from the Chinese database for the Chinese workers. These headforms were imported into PolyWorks for measurement. The same procedure was followed for placing points and taking all eleven measurements.

The data in Japanese population table below was originally separated into young adult male, older male, young adult female and older female. The other data tables are a combination of both males and females and therefore this table was created as a combination of both. These are the only four relevant measurements that could be extracted from the database.

Table B.1 — AIST data

Dimensions in millimetres

| Japanese Population | Minimum | 1st Quartile | Median | 3rd Quartile | Maximum | Average | St. Dev. |
|-------------------------|---------|--------------|--------|--------------|---------|---------|----------|
| Bizygomatic breadth | 124,0 | 138,0 | 142,0 | 147,0 | 158,0 | 142,1 | 6,31 |
| Interpupillary distance | 55,0 | 60,5 | 62,5 | 65,0 | 71,5 | 62,8 | 3,2 |
| Outer canthus | 79,0 | 87,0 | 90,0 | 93,0 | 102,0 | 93,1 | 4,3 |
| Inner canthus | 28,0 | 34,0 | 36,0 | 38,0 | 47,0 | 36,0 | 2,9 |