

Table 5 — Mean values for key facial dimensions of headforms

Dimensions in millimetres

Facial article	Headform cell 1 (small)	Headform cell 3 (short/wide)	Headform cells 2, 4, 5, 7 (medium)	Headform cell 6 (long/narrow)	Headform cell 8 (large)
A Minimum frontal breadth	98	106	104	103	110
B Face width	128	141	140	140	151
C Bigonial breadth	101	118	115	113	131
D Face ^a length	110	112	119	127	127
E Interpupillary distance	59	65	64	63	68
F Head breadth	142	149	150	151	158
G Nose protrusion	19	17	20	23	21
H Nose breadth	32	39	36	35	41
J Nasal root breadth	15	17	16	15	18
K Nose ^b length	47	44	50	56	52
^a Menton-sellion. ^b Subnasale-sellion.					

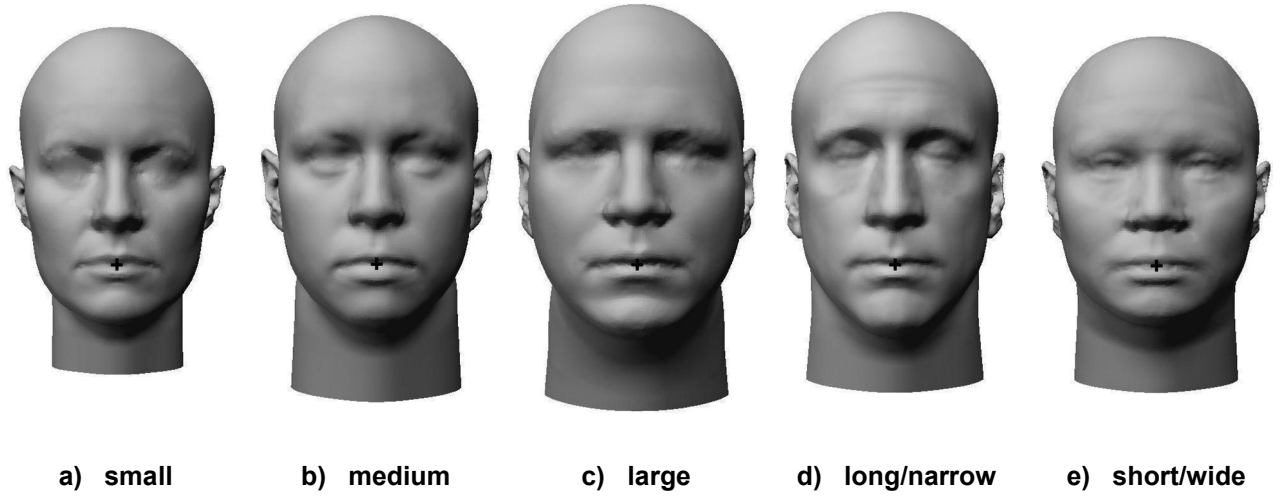
Based on the mean values for the ten key facial dimensions, five subjects with facial features close to these mean values for each model were selected. Five scans in each category were chosen based on PCA scores calculated from 3-D scan data and averaged together to construct a representative headform for each size category.

After scanned heads of the appropriate size and shape were identified and selected, the scan data were averaged to develop models of headforms using Polyworks software. Designing a single headform is a multi-step process. After subjects with scanned heads of the appropriate size and shape were selected, their 3-D scans were aligned using Polyworks, a program that allows the user to edit 3-D scans. In order to obtain the optimum average of the five subjects, each head scan was aligned using the Frankfort plane and a vertical symmetry plane constructed from the midpoint between three facial features for each scan. Once in proper alignment, Polyworks was used to create a single averaged headform from all five digital scans.

The resultant averaged headform may contain regions of missing information around important facial features such as the mouth, nose and eye regions. However, the forehead, cheeks and chin regions provide a smooth average. The medium average had holes in the eyes that required a simple patching procedure, but the nose was missing enough information to require an additional step. If necessary, subsequent alignments were used for individual facial features: the nose, lips and each eye. The average of the medium nose was stitched on to the initial average and the remaining holes were patched. Patching the headform included the removal of the noisy ear regions as well as creating a smooth scalp. Once the entire headform was patched, it was duplicated and mirrored so that a symmetric average of the headform could be created. Ears, a neck and a “+” sign at the centre of each mouth were added to complete each headform. The models of the five headforms are shown in Figure 6.

The digital models of headforms for producing physical models are available¹⁾.

1) Models of headforms are available at the: National Institute for Occupational Safety and Health, National Personal Protective Technology Laboratory, <http://www.cdc.gov/niosh/nppt/default.html>. This information is given for the convenience of users of this Technical Specification and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

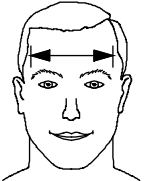
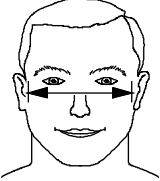
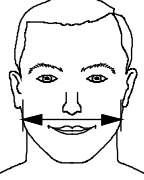
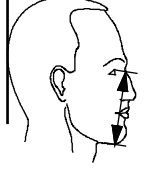
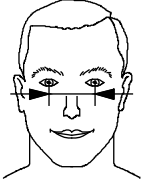
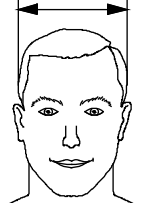
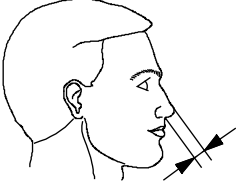


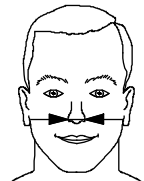

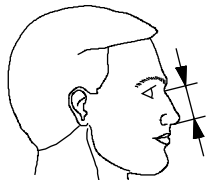
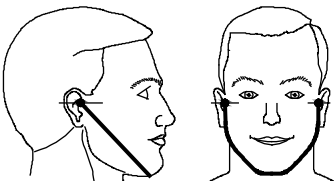
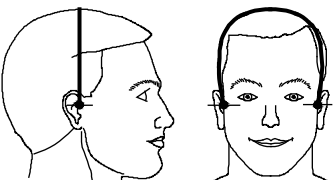
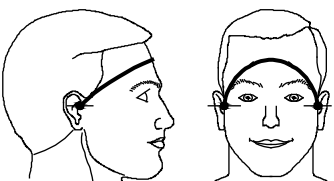
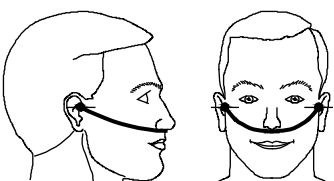
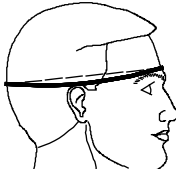
NOTE All headforms are lined up on their reference points, the centre of mouth opening.

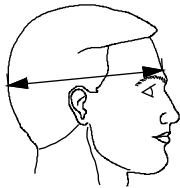
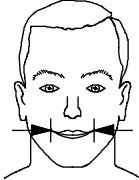
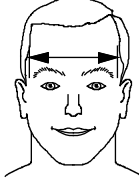

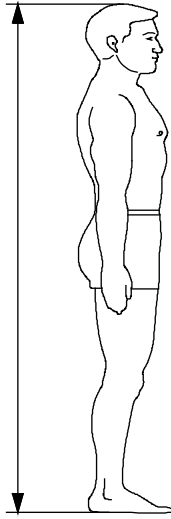
Figure 6 — Models of headforms

Annex B (normative)

Description, definition, and diagram of dimensions to be measured

Description	Definition	Diagram
A Minimum frontal breadth	The straight-line distance between the right and left frontotemporale landmarks on the temporal crest on each side of the forehead is measured with a spreading calliper. The subject sits looking straight ahead. Only enough pressure is exerted to ensure that the calliper tips are on the landmarks.	
B Face width	Maximum horizontal breadth of the face as measured with a spreading calliper between the zygomatic arches. The subject sits looking straight ahead and with teeth together (lightly occluded). Only enough pressure is exerted to ensure that the calliper tips are on the zygomatic arches.	
C Bigonial breadth	Straight-line distance measured with a spreading calliper between the right and left gonion landmarks on the corners of the jaw. The subject sits looking straight ahead and with teeth together (lightly occluded). Only enough pressure is exerted to ensure that the calliper tips are on the landmarks.	
D Menton-sellion length	The distance in the midsagittal plane between the menton landmark at the bottom of the chin and the sellion landmark at the deepest point of the nasal root depression is measured with a sliding calliper. The subject sits looking straight ahead and with teeth together (lightly occluded). The fixed blade of the calliper is placed on the sellion. Only enough pressure is exerted to obtain contact between the calliper and the skin is exerted.	
E Interpupillary distance	Distance as measured with a pupillometer at the centre of the right and the centre of the left pupil.	
F Head breadth	Maximum horizontal breadth of the head as measured with a spreading calliper above the level of the ears. The subject sits looking straight ahead. Enough pressure is exerted to obtain contact between the calliper and the skin.	
G Nose protrusion	The straight-line distance between the pronasale landmark at the tip of the nose and the subnasale landmark under the nose is measured with a sliding calliper. The subject sits looking straight ahead. The sliding blade of the calliper is reversed and the base of the calliper is placed on the subnasale landmark. The beam of the calliper is parallel to the line of the protrusion of the nose.	

Description	Definition	Diagram
H Nose breadth	Straight-line distance as measured with a sliding calliper between the right and left alare landmarks. The subject sits looking straight ahead. Only enough pressure is exerted to obtain contact between the calliper and the skin.	
J Nasal root breadth	The horizontal breadth of the nose at the level of the deepest depression in the root (sellion landmark) and at a depth equal to half the distance from the bridge of the nose to the eyes is measured with a sliding calliper. The subject sits looking straight ahead. The blunt points of the sliding calliper are used. Only enough pressure is exerted to obtain contact between the calliper and the skin.	
K Subnasale-sellion length	Straight-line distance as measured with a sliding calliper between the subnasale landmark and the sellion landmark. The subject sits looking straight ahead. Only enough pressure is exerted to obtain contact between the calliper and the skin.	
Bitrignon chin arc	The surface distance between the right and left trignon landmarks across the anterior point of the chin is measured with a tape. The subject sits looking straight ahead and with teeth together (lightly occluded). Enough tension is exerted to maintain light contact between the tape and the skin. The chin will be slightly compressed.	
Bitrignon coronal arc	The surface distance between the right and left trignon landmarks across the top of the head in the coronal plane is measured with a tape. The subject sits with head in the Frankfort plane. Enough tension is exerted to compress the hair.	
Bitrignon frontal arc	The surface distance between the right and left trignon landmarks across the forehead just above the ridges of the eyebrows (supraorbital ridges) is measured with a tape. The subject sits looking straight ahead. Enough tension is exerted to maintain light contact between the tape and the skin.	
Bitrignon subnasale arc	The surface distance between the right and left trignon landmarks across the subnasale landmark at the bottom of the nose is measured with a tape. The subject sits looking straight ahead. Enough tension is exerted to maintain light contact between the tape and the skin, but not enough to compress the soft tissue under the nose.	
Head circumference	The maximum circumference of the head just above the ridges of the eyebrows (supraorbital ridges) and the attachment of the ears is measured with a tape. The subject sits looking straight ahead. The plane of the tape will be higher in the front than in the back and the sides should be parallel. Enough tension is exerted to compress the hair.	

Description	Definition	Diagram
Head length	The maximum length of the head in the midsagittal plane is measured with a spreading calliper. The subject sits looking straight ahead. One tip of the calliper is placed on the glabella landmark between the brow ridges and the other tip is moved up and down the back of the head until a maximum measurement is obtained. Light pressure is exerted on the glabella and at the back of the head to compress the hair.	 A line drawing of a human head in profile, facing right. A horizontal line with arrows at both ends is drawn across the forehead, passing through the glabella. Another horizontal line with arrows at both ends is drawn across the back of the head, passing through the occipital protuberance. This represents the measurement of head length in the midsagittal plane.
Lip length	The straight-line distance between the right and left chelion landmarks at the corners of the closed mouth is measured with a sliding calliper. The subject sits looking straight ahead with teeth together (lightly occluded). The facial muscles are relaxed, and the mouth is closed.	 A line drawing of a human face from the front. Two horizontal lines with arrows at both ends are drawn across the corners of the closed mouth, representing the measurement of lip length.
Maximum frontal breadth	The straight-line distance between the right and left zygofrontale landmarks at the upper margin of each bony eye socket is measured with a spreading calliper. The subject sits looking straight ahead. Only enough pressure is exerted to ensure that the calliper tips are on the landmarks is exerted.	 A line drawing of a human face from the front. Two horizontal lines with arrows at both ends are drawn across the upper margin of each bony eye socket, representing the measurement of maximum frontal breadth.
Neck circumference	The circumference of the neck at the level of the infrathyroid landmark (Adam's apple) is measured with a tape. The plane of the measurement is perpendicular to the long axis of the neck. The subject stands erect with head in the Frankfort plane. The shoulders and upper extremities are relaxed.	 A line drawing of a human torso from the side. A horizontal line with arrows at both ends is drawn around the neck at the level of the Adam's apple, representing the measurement of neck circumference.
Stature	The vertical distance between the standing surface and the top of the head is measured with an anthropometer. The subject stands erect with heels together and head in the Frankfort plane. The shoulders and arms are relaxed. Enough pressure is exerted to compress the hair. The measurement is taken at the maximum point of quiet respiration.	 A line drawing of a human figure from the side, standing upright. A vertical line with arrows at both ends is drawn from the top of the head to the standing surface, representing the measurement of stature.
Weight	The weight of the subject is taken to the nearest half kilogram. The subject stands on the centre of the platform looking straight ahead. The heels are together and the weight evenly distributed on both feet.	