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Aeronavtika - Antropometrično dimenzioniranje letalskih sedežev

Aerospace series - Anthropometric dimensioning of aircraft seats

Luft- und Raumfahrt - Anthropometrische Dimensionierung von Flugzeugsitzen

Série aérospatiale - Dimensionnement anthropométrique des sièges passagers d'avion

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Luft- und Raumfahrt - Anthropometrische Dimensionierung von Flugzeugsitzen

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European foreword

This document (EN 4730:2018) has been prepared by the Aerospace and Defence Industries Association of Europe — Standardization (ASD-STAN).

After enquiries and votes carried out in accordance with the rules of this Association, this Standard has received the approval of the National Associations and the Official Services of the member countries of ASD, prior to its presentation to CEN.

This document shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2019, and conflicting national standards shall be withdrawn at the latest by May 2019.

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Introduction

Flight passengers in commercial aviation spend the predominant part of their journey — which can take 12 hours or more — on their seats. Therefore, aircraft passenger seats are designed to minimize passengers' discomfort. This includes the consideration of body size and its variation within the target population.

This document gives guidance on the use of anthropometric data for the dimensioning of aircraft seats to accommodate specific populations as well as mixed populations including the world population. This document also gives advice on how to quantify seat comfort in terms of anthropometric accommodation rates.

1 Scope

This document describes the application of anthropometric data for the dimensioning of aircraft passenger seats. The focus is on the use of statistical parameters of anthropometrical measurements as given in CEN ISO/TR 7250-2 and similar sources. Even if methods described in this document might be applicable for feasibility and safety issues the scope of this document is design for comfort.

The aim of this document is to give advice to designers to include methods of human-centred design into the design of aircraft seats.

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.

EN 4723:2015, *Aerospace series — Standardized measurement methods for comfort and living space criteria for aircraft passenger seats*

EN ISO 15535:2012, *General requirements for establishing anthropometric databases (ISO 15535:2012)*

EN ISO 7250-1, *Basic human body measurements for technological design — Part 1: Body measurement definitions and landmarks*

CEN ISO/TR 7250-2, *Basic human body measurements for technological design — Part 2: Statistical summaries of body measurements from national populations*

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
anthropometry
study and measurement of the physical dimensions and mass of the human body and its constituent (external) parts

Note 1 to entry: Taken from the Greek word *anthropos* (human being or Man) and *metron*, to measure.

[SOURCE: EN ISO 15535:2012, 3.6]

3.2
anthropometric data
dimensional measurements (such as heights, lengths, depths, breadths and circumferences) of the human body and its component parts

[SOURCE: EN ISO 15535:2012, 3.7]

3.3
percentile
statistical parameter indicating the value a given percentage of observations in a population go below

Note 1 to entry: For example 5 % of a population is shorter than the 5th percentile of stature of this population.

3.4
high percentile
percentile of a distribution of measurements of a body dimension representing a tall or corpulent person

Note 1 to entry: For assessment of comfort usually the 95th percentile is used.

3.5
low percentile
percentile of a distribution of measurements of a body dimension representing a short person

Note 1 to entry: For assessment of comfort usually the 5th percentile is used.

3.6
sitting height (erect)
vertical distance from a horizontal sitting surface to the highest point of the head (vertex)

Note 1 to entry: The definition is in line with ISO 7250-1.

3.7
eye height, sitting
vertical distance from a horizontal sitting surface to the outer corner of the eye

Note 1 to entry: The definition is in line with ISO 7250-1.

3.8
cervicale height, sitting
vertical distance from a horizontal sitting surface to the cervicale (spinous process of the seventh cervical vertebra)

Note 1 to entry: The definition is in line with ISO 7250-1.

3.9
elbow height, sitting
vertical distance from a horizontal sitting surface to the lowest bony point of the elbow bent at a right angle with the forearm horizontal

Note 1 to entry: The definition is in line with ISO 7250-1.

3.10
shoulder (bideltoid) breadth
distance across the maximum lateral protrusions of the right and left deltoid muscles

Note 1 to entry: The definition is in line with ISO 7250-1.

3.11
hip breadth, sitting
Breadth of the body measured across the widest portion of the hips

Note 1 to entry: The definition is in line with ISO 7250-1.

3.12
lower leg length
popliteal height
vertical distance from the foot-rest surface to the lower surface of the thigh immediately behind the knee, bent at right angles

Note 1 to entry: The definition is in line with ISO 7250-1.

3.13
thigh thickness
thigh clearance
vertical distance from the sitting surface to the highest point on the thigh

Note 1 to entry: The definition is in line with ISO 7250-1.

3.14
knee height
vertical distance from the floor to the highest point of the superior border of the patella

Note 1 to entry: The definition is in line with ISO 7250-1.

3.15
buttock-popliteal length (seat depth)
horizontal distance from the hollow of the knee to the rearmost point of the buttock

Note 1 to entry: The definition is in line with ISO 7250-1.

3.16
buttock-knee length
horizontal distance from the foremost point of the knee-cap to the rearmost point of the buttock

Note 1 to entry: The definition is in line with ISO 7250-1.

3.17
deat width between armrests
SWAR
shortest distance between two armrests flanking a seat place

Note 1 to entry: EN 4723 can be used for more information.

3.18
armrest top height over seat bottom cushion
TACH
distance between the compressed seat bottom and the highest point of the upper armrest contour

Note 1 to entry: EN 4723 can be used for more information.

3.19
vushion height above cabin floor level
CHoF
perpendicular distance from highest point at the front edge of the uncompressed cushion to the airplane floor plane

Note 1 to entry: EN 4723 can be used for more information.

3.20
table height over bottom cushion edge
TH
distance between the two parallel planes set up by the front lower edge of the meal tray table spread horizontally to the rear and a horizontal plane touching the highest edge of the seat bottom cushion

Note 1 to entry: EN 4723 can be used for more information.

3.21
total seat width
TSW
shortest distance between the arm rest centre lines flanking a seat (SWAR plus 2 × half width of armrest)

4 Engineering anthropometry

4.1 Anthropometric design

The objective of anthropometric design is to adjust the dimensions of workplaces, interior space of vehicles, furniture, equipment, or protective clothing to the size of the human body. There are various approaches to consider the variety of dimensions and proportions in populations: Sizing systems (e.g. garment), adjustable elements (e.g. seat position in cars) or designing to critical cases (e.g. seats in public transport vessels). Aircraft passenger seats belong to the latter category.

4.2 “Fit” and “Reach” problems

Design to critical cases means to dimension an item so as to fully accommodate all users with the exception of few, which are beyond the critical case. Regarding the critical case “fit” and “reach” problems might be distinguished. For instance, if the width of a seat is dimensioned according to the hip width of a corpulent reference person; all individuals with smaller hips will also fit into the seat (“Fit” problem). In contrast, the height of the seat pan should be dimensioned to allow a reference person with short legs to reach the floor with the feet (“Reach problem”). Accommodation to people with longer legs is given when they increase their knee angle. Generally, in case of “fit problems” dimensioning is adjusted for a large reference person, in case of “reach problems” for a small reference person.

NOTE Accommodation to an average person (mean or median of population data) is in most cases not a reasonable option, since half of the population will likely not fit or reach.

4.3 Percentiles and design limit

Small and large reference persons are defined by statistical parameters of the distribution of the respective sizes (e.g. leg length) in the population. Typically, this is done by fixing a low and a high percentile level (design limit). The n^{th} percentile of a distribution is the value where n percent of all cases in the distribution fall below. For instance, the 95^{th} percentile of the stature of a population is the body height where 95 % of the respective population is shorter (or 5 % are taller). Usually, a value between the 1^{st} and the 5^{th} percentile (i.e. for 1 resp. 5 % of the population the respective dimension is smaller) is used as small reference and a value between 95^{th} and 99^{th} percentiles as large reference.

NOTE 1 Percentile values (1st, 5th, 50th, 95th, and 99th) for various body measurements and populations can be found in CEN ISO/TR 7250-2.

NOTE 2 Additional information regarding statistical properties of anthropometrical data is given in Annex A.

For comfort and efficiency related studies typically a range from 5th to 95th percentile is applied. Generally, a decision for a design limit should be accompanied by considerations regarding the portion of the population not accommodated within the defined range. Consequences of non-accommodation can be impossibility of use, reduction of comfort, lack of safety or another restriction. A design limit defined by the 5th and 95th percentile can exclude 5 % of the population, and — in case several measurements are critical at the same time — even more. For safety relevant dimensions the use of 1st and 99th percentile is recommended according to EN 547-1 and to EN 614-1.

NOTE 3 Aviation regulations can define individual percentiles or constants for certain tests (e.g. CS 25.562).

4.4 Means and procedure

In various phases of the product life-cycle anthropometric studies might be performed with different means. The use of 2D Templates, 3D CAD manikins, anthropomorphic test devices (dummies) or tests with a sample of real humans (EN ISO 15537 gives advice for the selection of test persons) are just some examples. All methods should be based on appropriate anthropometrical data.

Some techniques have specific prerequisites, e.g. a digital 3D model or a physical prototype. The direct use of percentilized measurement data as described in this document has minimal requirements and can be performed in very early design stages.

NOTE Since 2D/3D templates or manikins cannot represent a certain percentile in all dimensions (e.g. stature, trunk length, and leg length) at a time design results typically differ slightly from dimensioning with tabulated percentile data.

The general procedure includes:

— identification of target group (according to parameters as nationality/ethnicity, gender, age range) (5.1);

— selection of an appropriate data set (in terms of representing the target group) (5.2);

— selection of relevant anthropometric measurements (corresponding to required seat dimensions; e.g. hip width for dimensioning seat width) (5.3);

— adjustment of anthropometrics dimensions by taking into acoount clothing and posture corrections (5.4);

— calculation of design dimensions by adding clearances (for fit dimensions) or subtracting margins (for reach dimensions) (5.5);

— consideration of compression of cushion (5.6);

— integration and evaluation of results (5.7);

— documentation (5.8).