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Earth-moving machinery — Physical dimensions of operators and minimum operator space envelope

Engins de terrassement — Dimensions des opérateurs et espace enveloppe minimal pour les opérateurs

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Contents

Page

Foreword iv
Introduction v
1 Scope 1
2 Normative references 1
3 Terms and definitions 1
4 Physical dimensions of operators 2
5 Minimum operator space envelope 6
Bibliography 10

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 3411 was prepared by Technical Committee ISO/TC 127, *Earth-moving machinery*, Subcommittee SC 2, *Safety requirements and human factors*.

This fourth edition cancels and replaces the third edition (ISO 3411:1995), which has been technically revised.

Introduction

The operator dimensions in this International Standard are derived from male and female data from the United States of America (CAESAR Data), Europe (ISO 15534-3:2000) and Asia (China, Japan, Korea and Thailand).

The dimensions of the male Asian data were found to be within the range of the 5^{th} and 95^{th} percentiles of the combined USA and European data. Thus, to represent the operator populations for the USA and Europe, the operator dimension data are based upon the data from those two regions. To account for the potential increase in female Asian operators, the small operator dimension values were maintained from ISO 3411:1995 and used instead of the larger dimensions from the USA and European data.

The dimensions given in this International Standard are either actual measurements obtained from the sources listed above or, when specific dimensions were not available, were derived by proportionally scaling the values from ISO 3411:1995, based on the trend of growth seen across the available measured dimensions.

The operator minimum normal interior space envelope for enclosures stated in this International Standard can be supplemented or modified by standards for specific earth-moving machinery.

Earth-moving machinery — Physical dimensions of operators and minimum operator space envelope

1 Scope

This International Standard provides the dimensions of operators of earth-moving machinery as defined in ISO 6165 and specifies the minimum normal operating space envelope within the operator enclosures.

It is not applicable to machines manufactured prior to the date of its publication.

2 Normative references

The following referenced documents are indispensable for the application 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 5353:1995, *Earth-moving machinery, and tractors and machinery for agriculture and forestry — Seat index point*

ISO 6165:2006, *Earth-moving machinery — Basic types — Identification and terms and definitions*

ISO 11112:1995, *Earth-moving machinery — Operator's seat — Dimensions and requirements*

3 Terms and definitions

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

3.1
small operator
operator belonging to the worldwide earth-moving machinery operator population where approximately 5 % of operators are smaller than the dimension listed

3.2
medium operator
operator belonging to the worldwide earth-moving machinery operator population where approximately 50 % of operators are smaller than the dimension listed and the remaining worldwide earth-moving machinery operator population is larger than the dimension listed

3.3
large operator
operator belonging to the worldwide earth-moving machinery operator population where approximately 5 % of operators are larger than the dimension listed

3.4
working posture
posture an operator assumes while doing work

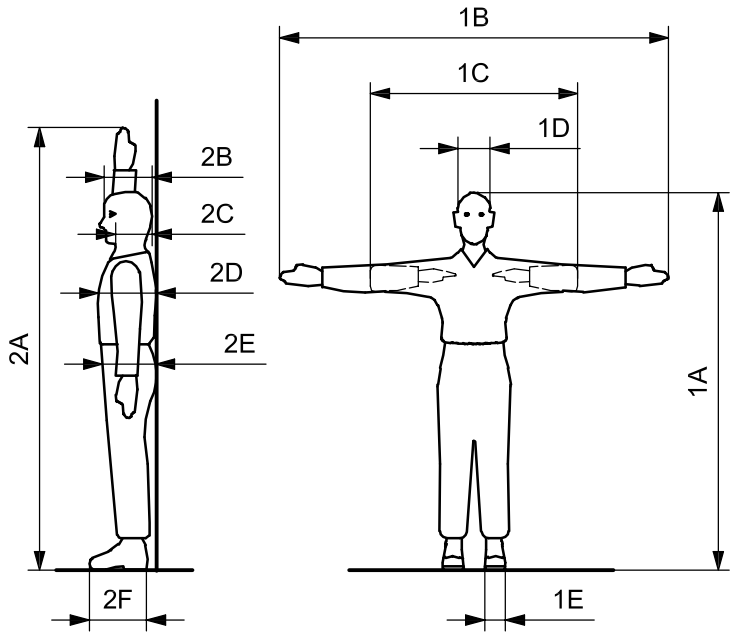
3.5
erect posture
standing or sitting upright without a backrest

4 Physical dimensions of operators

The ranges of physical dimensions for standing and seated operators are shown in Figures 1 and 2. The ranges of derived body pivot dimensions are shown in Figure 3. The dimensions include a 25 mm allowance for the height of shoes or boots. The influence of other clothing is insignificant on these dimensions.

All dimensions are for an operator in an erect posture. A working posture is typically relaxed and the dimensions will be slightly less: stature (1A) and overhead reach (2A) will be reduced by about 15 mm, while sitting height (3A) and sitting eye height (3B) will be reduced by about 25 mm.

In some areas of the world, more than 5 % of the operators have leg lengths less than the values given for the small operators. To accommodate these areas, special adjustments may be provided.



Reference	Designation	Dimension mm		
		Small operator	Medium operator	Large operator
1A	Stature (with shoes) [a]	1 550	1 730	1 905
1B	Arm span [c]	1 585	1 765	1 942
1C	Arm span (elbows folded) [c]	850	958	1 060
1D	Head breadth [b]	140	151	163
1E	Foot breadth (with shoes)	95	125	139
2A	Overhead reach (fingertip) [c]	1 900	2 118	2 325
2B	Head length	170	194	210
2C	Eye to back distance [c]	170	194	210
2D	Chest depth [c]	210	247	280
2E	Abdominal depth [c]	210	257	300
2F	Foot length (with shoes)	250	276	311

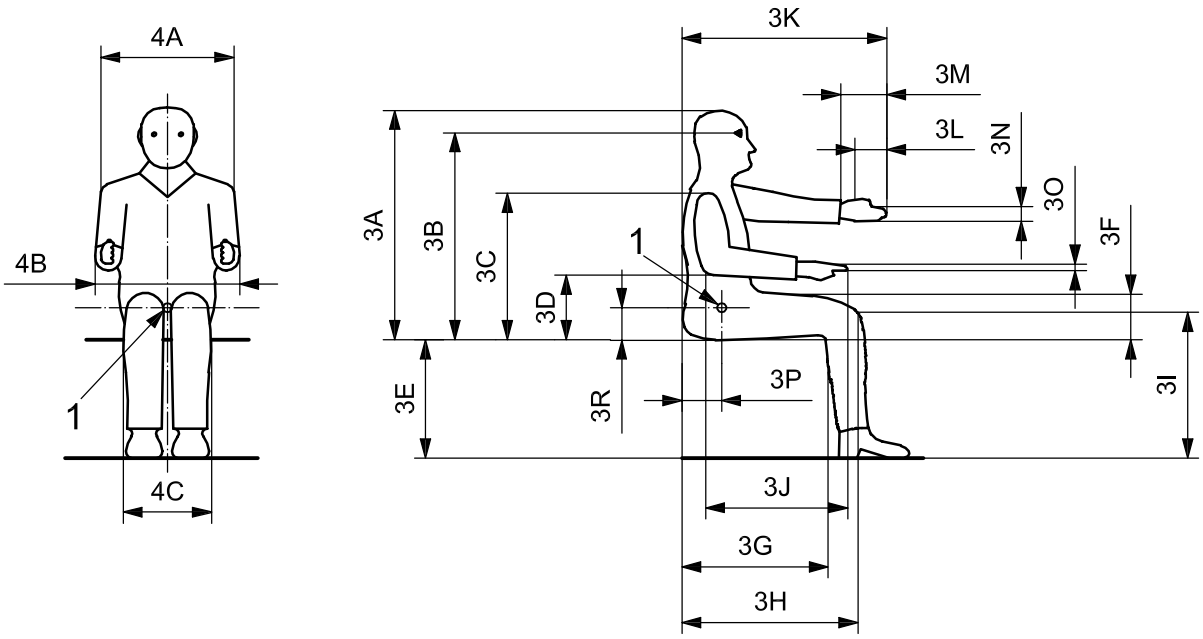
NOTE These columns represent the measured size range of the world population. Small is approximately the 5th percentile measurement, medium is approximately the 50th percentile measurement, and large is approximately the 95th percentile measurement. Small operator = 51,9 kg, medium operator = 74,4 kg, large operator = 114,1 kg.

[a] Add approximately 50 mm for protective helmet, if required.

[b] Dimension for head breadth does not include the ears.

[c] The dimensional values were derived through proportional scaling.

Figure 1 — Dimensions derived with operator in standing position



Reference	Designation	Dimension mm		
		Small operator	Medium operator	Large operator
3A	Sitting height [a]	800	894	976
3B	Eye height, sitting	690	780	858
3C	Shoulder height, sitting	530	585	651
3D	Elbow height, sitting	200	239	285
3E	Horizontal sitting surface height [c]	400	449	495
3F	Thigh clearance [c]	120	146	170
3G	Buttock to calf distance [c]	420	474	525
3H	Buttock-knee length	530	601	670
3I	Knee height, sitting (with shoes)	500	558	627
3J	Forearm-fingertip length [c]	410	464	515
3K	Anterior arm reach [c]	750	832	909
3L	Decrement for control grasp [c]	−65	−73	−80
3M	Hand length	170	190	207
3N	Hand breadth [b, c]	80	87	96
3O	Hand thickness [c, d]	25	30	35
3P	SIP (seat index point) length	113	125	137
3R	SIP (seat index point) height	80	88	97
4A	Shoulder (bi-deltoid) breadth	380	450	514
4B	Elbow-to-elbow breadth [c]	385	454	521
4C	Hip breadth, sitting	320	378	456

1 seat index point (SIP)

NOTE These columns represent the measured size range of the world population. Small is approximately the 5th percentile measurement, medium is approximately the 50th percentile measurement, and large is approximately the 95th percentile measurement. Small operator = 51,9 kg, medium operator = 74,4 kg, large operator = 114,1 kg

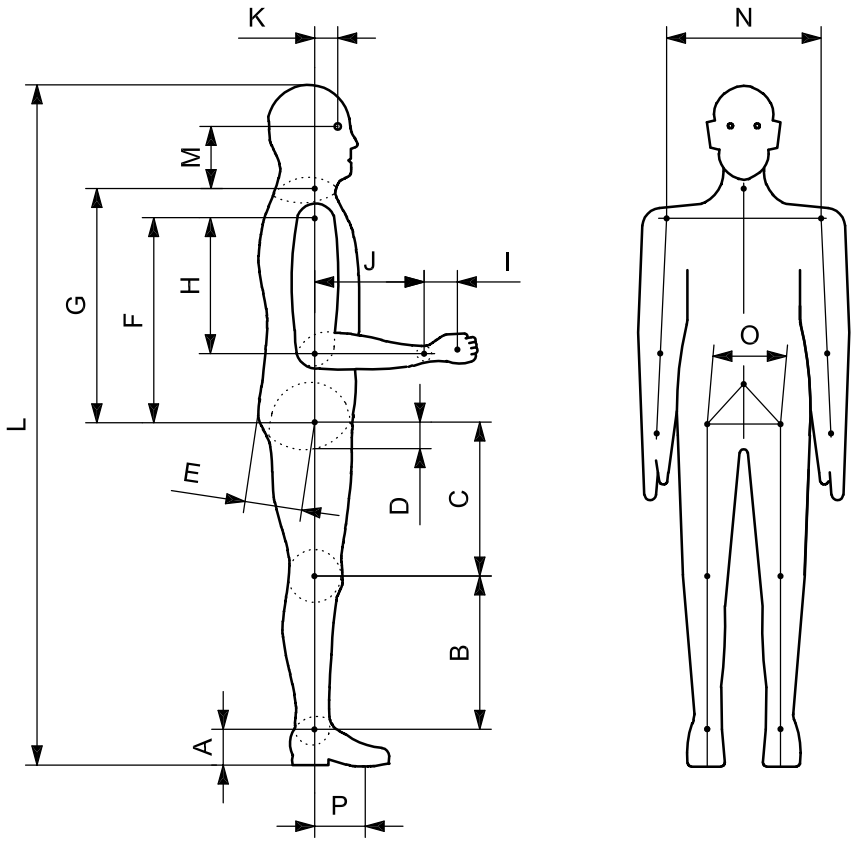
[a] Add approximately 50 mm for a protective helmet, if required.

[b] The dimension for hand breadth does not include the thumb.

[c] The dimensional values were derived through proportional scaling.

[d] The dimension for hand thickness relates to the thickness at the base of the fingers, not the palm thickness.

Figure 2 — Dimensions derived with operator in seated position



Reference	Designation	Dimension mm		
		Small operator	Medium operator	Large operator
A	Ankle height (with shoes)	98	107	120
B	Lower leg length	367	405	450
C	Thigh length	372	425	475
D	Hip point to buttock (vertical) [a, b]	80	88	97
E	Hip point to buttock (fore-aft) [b]	113	125	137
F	Trunk length	396	442	486
G	Hip point to neck pivot [a, b]	481	538	591
H	Upper arm length [b]	247	276	303
I	Wrist to control grasp [b]	105	119	137
J	Forearm length [b]	220	246	270
K	Eye to body centerline [b]	71	79	87
L	Stature (with shoes)	1 550	1 730	1 905
M	Eye level to neck pivot [b]	133	149	164
N	Shoulder pivot width [b]	310	349	382
O	Hip pivot width [b]	152	170	187
P	Ankle to pedal force point [b]	124	138	152

[a] For the operator in the sitting position.

[b] The dimensional values were derived through proportional scaling.

Figure 3 — Body pivot dimensions

5 Minimum operator space envelope

5.1 General

The minimum operator space envelope is the interior dimension of the operator's enclosure. The minimum operating space envelope around the operator for operator enclosures (e.g. cabs, ROPS, FOPS) is shown in Figure 4 for a seated operator and in Figure 5 for a standing operator. The dimensions given relate to the seat index point (SIP), as defined in ISO 5353. The outline of the space envelope does not imply the shape of the enclosure. This shape can be different than those illustrated provided that the minimum dimensions are met.

The minimum operator space envelope is based on the large operator dimensions shown in Figures 1, 2 and 3 and is measured to the interior surface without visible surface deformation of the operator enclosure.

5.2 Allowable adjustments

5.2.1 Allowable adjustments to the minimum operator space envelope for particular machine applications and constraints are given in 5.2.2, 5.2.3, 5.2.4 and 5.2.5. The minimum operator space envelope requirements stated in this International Standard can also be supplemented or modified by standards for specific earth-moving machinery.

5.2.2 The operator enclosure minimum space envelope may be smaller than according to Figures 4 and 5 if the reduced operator space envelope for a particular machine application allows adequate space for operator performance and protection. Acceptable modifications for the operator enclosure space envelope include the following.

5.2.2.1 An operator enclosure minimum height of 1 050 mm from the SIP is required to accommodate commonly used seats and provide clearance for an operator's protective helmet. The operator enclosure minimum height may be reduced to 1 000 mm for machines used in applications for which a protective helmet is not required in the enclosure.

5.2.2.2 The enclosure height may also be adjusted for the following variations in seat configurations as defined in ISO 11112:

a) 40 mm reduction without vertical seat suspension;

b) 40 mm reduction without vertical seat height adjustment;

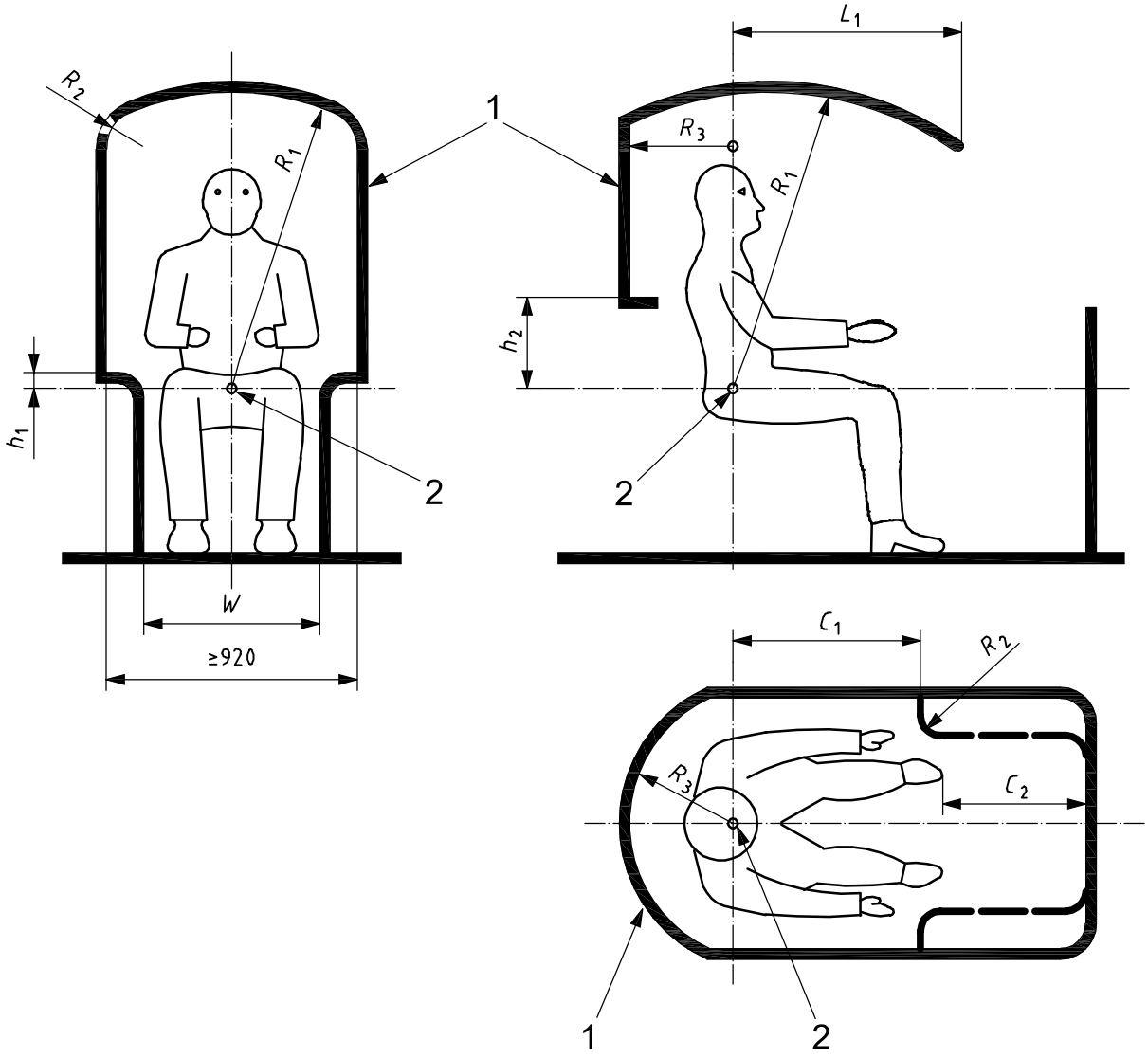
c) reduction proportional to seat back cushion angle greater than 15°.

5.2.3 The operator seat may be offset from the space envelope width centreline to allow direct visibility to the side of the machine, provided the minimum internal distance from the SIP to the side of the upper portion of the enclosure is at least 325 mm.

5.2.4 Some particular types of machines (e.g. compact machines) can necessitate the use of an operator space envelope smaller than the minimum recommended by this International Standard. For these machines, the internal operator's space envelope width may be reduced to a minimum of 650 mm. This minimum width space envelope requires judicious placement of operator controls to ensure operator performance and comfort.

5.2.5 When the operator is normally inclined forward to operate the steering controls (e.g. compact excavator), or visibility to the immediate rear of the machine is required (e.g. small tractor dozer), the minimum clearance to the rear of the operator enclosure (R_3) may be reduced to 250 mm plus one half of the fore-aft seat adjustment travel.

Dimensions in millimetres



Key

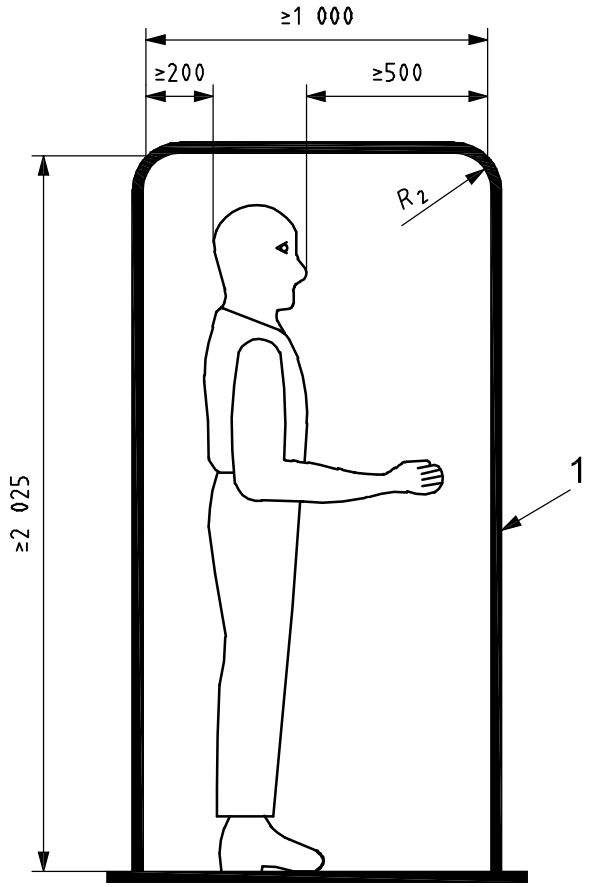
1 interior space envelope (ISE)

2 seat index point (SIP)

NOTE Width dimensions shown are symmetrical. See Table 1 for the values of the dimensions shown here.

Figure 4 — Normal minimum operator interior space envelope for enclosure — Seated operator

Dimensions in millimetres



Key

1 interior space envelope (ISE)

NOTE Dimension R_2 is given in Table 1. Enclosure width dimensions and clearance for controls are the same as those shown in Figure 4.

Figure 5 — Normal minimum operator interior space envelope for enclosure — Standing operator

Table 1 — Dimensions (see Figures 4 and 5)

Symbol	Designation	Dimension mm
R_1	Distance between SIP and enclosure ceiling in transverse plane	[a]
	— with operator wearing protective helmet, on seat with suspension and adjustment	$\geqslant$1 050
	— with operator not wearing protective helmet, on seat with suspension and adjustment	$\geqslant$1 000
R_2	Radius at intersection of enclosure's internal walls with each other and with ceiling	$\leqslant$ 250
R_3	Distance towards rear	[b]
L_1	Horizontal distance between SIP and enclosure in which R_1 is to be maintained	$\geqslant$ 500
h_1	Vertical distance between SIP and lower end of upper side walls of enclosure	$\leqslant$ 150
h_2	Vertical distance between SIP and lower end of upper back wall of enclosure	[c]
W	Width within space for legs	$\geqslant$ 560
C_1	Clearance for forearm/hand within upper side areas of enclosure	$\geqslant$ 500
C_2	Clearance between enclosure and operator's shoe working pedal or foot control in any position	$\geqslant$ 30

[a] The minimum distance from the SIP to a window retracted above the operator head shall be 920 mm.

[b] At least b + 400 mm, where b is equal to half the horizontal seat adjustment dimension. See 5.2.5.

[c] This dimension shall be equal to or less than the vertical distance between the SIP and the top of the seat back cushion adjusted to its lowest position.

Bibliography

[1] ISO 7250:1996, *Basic human body measurements for technological design*

[2] ISO 15534-3:2000, *Ergonomic design for the safety of machinery — Part 3: Anthropometric data*

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