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**Earth-moving machinery — Human  
physical dimensions of operators and  
minimum operator space envelope**

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*Engins de terrassement — Dimensions ergonomiques des opérateurs et  
espace enveloppe minimal des postes de travail*

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## Foreword

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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.

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

This third edition cancels and replaces the second edition (ISO 3411:1982), of which it constitutes a technical revision.

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# Earth-moving machinery — Human physical dimensions of operators and minimum operator space envelope

## 1 Scope

This International Standard defines the dimensions of male operators of earth-moving machinery and specifies the minimum normal operating space envelope around the operator enclosures (cabs, ROPS, FOPS) generally applicable to earth-moving machinery.

It applies to earth-moving machines as defined in ISO 6165.

## 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 5353:1995, *Earth-moving machinery, and tractors and machinery for agriculture and forestry — Seat index point*.

ISO 6165:1987, *Earth-moving machinery — Basic types — Vocabulary*.

ISO 6682:1986, *Earth-moving machinery — Zones of comfort and reach for controls*.

ISO 6682:1986/Amd.1:1989, Amendment 1.

## 3 Definitions

For the purposes of this International Standard, the following definitions apply (see figure 1).

**3.1 small operator:** Operator where only 5 % of the worldwide earth-moving machinery operator population is smaller than the dimensions given.

**3.2 medium operator:** Operator where 50 % of the worldwide earth-moving machinery operator population is smaller and larger than the dimensions given.

**3.3 large operator:** Operator where only 5 % of the worldwide earth-moving machinery operator population is larger than the dimensions given.

## 4 Physical dimensions of operators

### 4.1 General

The physical dimensions of small, medium and large operators are given in figures 2 and 3 for standing and sitting operators respectively. The body pivot dimensions for small, medium and large operators are given in figure 4.

NOTE 1 The dimensions of large and small earth-moving machinery operators were derived by combining national data to represent the worldwide operator population. Therefore a small number of the smallest and largest national operators will be smaller or larger respectively than the 5th and 95th percentile worldwide operator population. Nominally 75 mm of vertical seat adjustment is recommended to accommodate these operators. See ISO 6682:1986, annex A.

## 4.2 Dimensions

The dimensions given include an allowance for the height of shoes or boots and the thickness of work clothing. In the "large operator (arctic clothes)" column in tables of figures 2, 3 and 4, the dimensions are of uncompressed clothing (except where the operator is seated) with heavy mittened hands and the head covered with parka hood.

## 4.3 Erect posture

All dimensions are of an operator in an erect posture. A normal posture is "slumped" and the dimensions will be slightly less: stature (1A) and overhead reach (2A) will be reduced about 15 mm, while sitting chest height (3A) and sitting eye height (3B) will be reduced about 25 mm.

## 5 Minimum operator space envelope

**5.1** The minimum operator space envelope is the interior dimension of the operator's enclosure. The minimum recommended operating space envelope around the clothed operator for operator enclosures (cabs, ROPS, FOPS) is given in figure 5 for a seated operator and in figure 6 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. Potential adjustments to the minimum operator space envelope for particular machine applications and constraints are given in 5.3, 5.5 and 5.6.

**5.2** The minimum operator space envelope is based on the large operator dimensions given in figures 2 and 3, and is measured to the interior surface without visible surface deformation of the operator enclosure.

**5.3** The operator enclosure minimum space envelope may be smaller than specified in figures 5 and 6 if it can be demonstrated that the reduced operator space envelope for a particular machine application allows for adequate operator performance. Potential modifications for the operator enclosure space envelope include, but are not limited to the following.

**5.3.1** An operator enclosure minimum height of 1 050 mm from the SIP is recommended to accommodate commonly used seats and provide clearance for an operator's protective helmet. The operator enclosure minimum height can be reduced to 1 000 mm for machines used predominantly in applications in which the operator normally does not wear a protective helmet. See ISO 5353 for details on SIP.

**5.3.2** The enclosure height can also be adjusted for the following variations in seat configurations:

- a) 40 mm reduction without vertical seat suspension;
- b) 40 mm reduction without vertical seat height adjustment;
- c) adjustment for seat back rest angle greater than 15°.

**5.4** The operator may be offset from the space envelope width centreline to allow direct visibility to the side of the machines, provided the minimum internal distance from the SIP to the side of the enclosure is at least 335 mm.

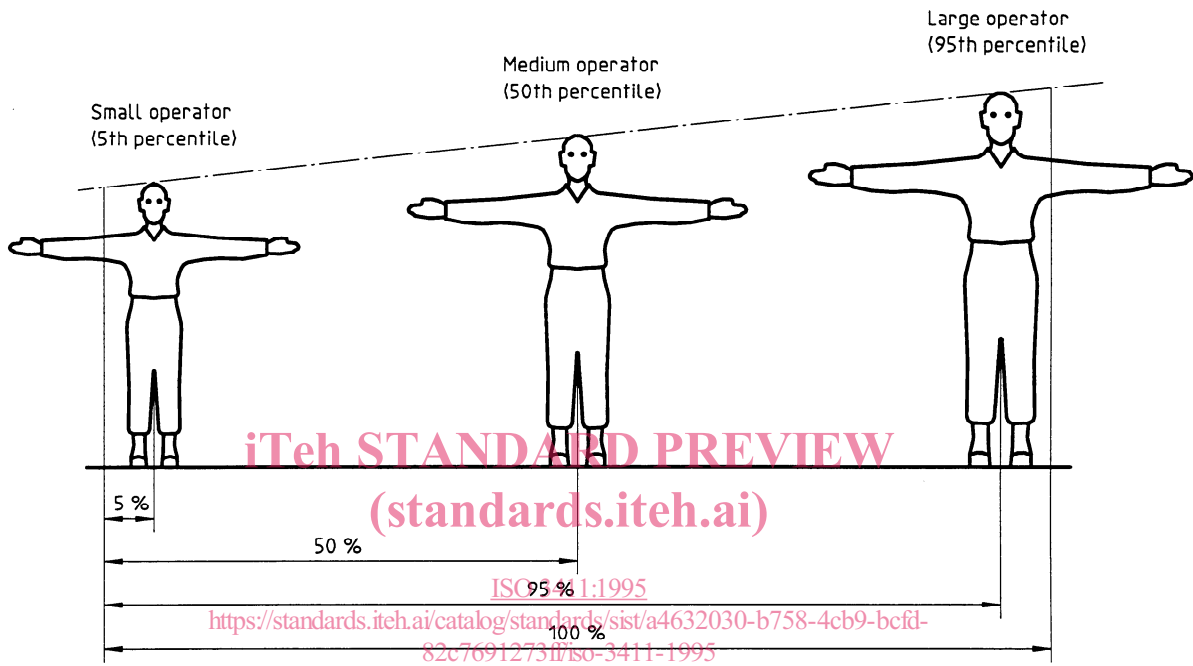
**5.5** Some particular types of machines may necessitate use of an operator space envelope smaller than the minimum recommended by this International Standard. For these machines, the internal operator's space envelope width may be reduced to a minimum of 650 mm. This minimum width space envelope requires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

**5.6** When the operator is normally inclined forward to operate the steering controls or access to a control to the rear of the SIP is required, the minimum clearance to the rear of the operator enclosure can be reduced to 250 mm plus one half of the fore-aft seat adjustment travel.

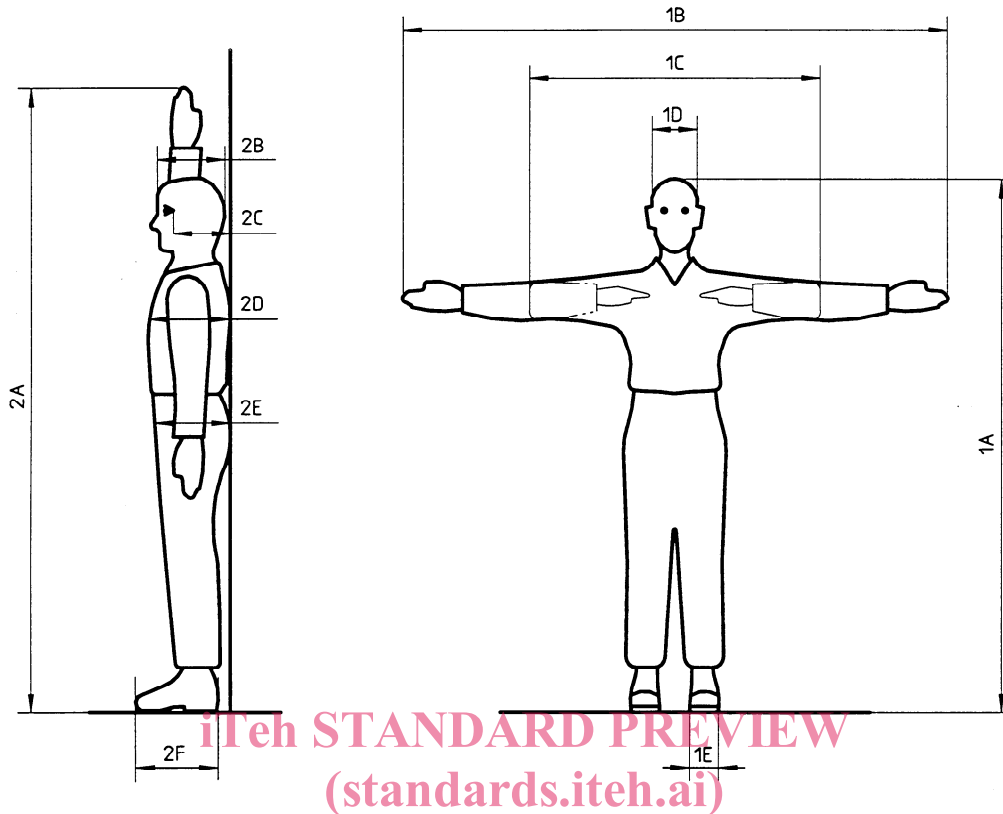
**5.7** For the locations of controls, see ISO 6682.

NOTE 2 In some areas of the world, there are more than 5 % of the operators that have leg lengths less than the

values given for the small operators. To accommodate these areas of the world, special adjustments should be provided for zones of comfort and reach for the foot, as specified in ISO 6682:1986/Amd.1.



**Figure 1 — Dimensions of operators**



Dimensions in millimetres

Reference	Designation	Small operator (55 kg)	Medium operator (76.5 kg)	Large operator (98 kg)	Large operator (arctic clothes) (109 kg)
1A	Stature <sup>1) 2)</sup>	1 550	1 715	1 880	1 920
1B	Arm span	1 585	1 750	1 920	1 960
1C	Arm span, elbows folded	850	950	1 050	1 125
1D	Head width <sup>3) 4)</sup>	140	152	165	265
1E	Shoe width	95	105	115	140
2A	Overhead reach (fingertip) <sup>2)</sup>	1 900	2 100	2 300	2 325
2B	Head length <sup>4)</sup>	170	188	205	255
2C	Eye to back distance	170	188	205	245
2D	Chest depth	210	245	280	355
2E	Abdominal depth	210	255	300	400
2F	Shoe length	250	285	320	345

1) Add approximately 50 mm for protective helmet, except for the large operator (arctic clothes). See 4.2.

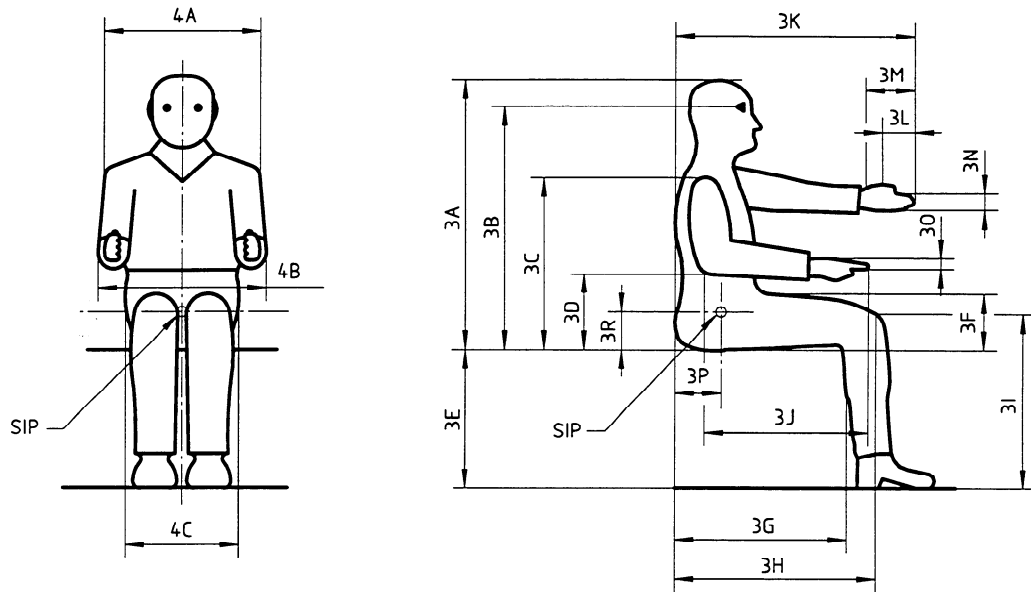
2) See 4.3.

3) Dimensions for head width do not include the ears.

4) Protective helmets: length: ≈ 310 mm; width: ≈ 270 mm

Helmets: length: ≈ 280 mm; width: ≈ 230 mm

Figure 2 — Dimensions for standing clothed operator



Dimensions in millimetres

Reference	Designation	Small operator	Medium operator	Large operator	Large operator (arctic clothes)
3A	Chest height, sitting <sup>1) 2)</sup>	800	880	960	990
3B	Eye height, sitting <sup>2)</sup>	690	765	840	850
3C	Shoulder height	530	590	650	680
3D	Elbow height	200	235	270	260
3E	Horizontal sitting surface height	400	445	490	490
3F	Thigh thickness	120	145	170	200
3G	Back to calf distance	420	470	520	500
3H	Back to knee length	530	590	650	680
3I	Knee height	500	560	620	640
3J	Forearm to hand length	410	460	510	535
3K	Anterior arm reach	750	825	900	915
3L	Decrement for control grasp	-65	-72	-80	-85
3M	Hand length	170	188	205	210
3N	Hand width <sup>3)</sup>	80	86	95	105
3O	Hand thickness <sup>4)</sup>	25	30	35	45
3P	SIP length	113	125	137	147
3R	SIP height	80	88	97	107
4A	Shoulder width	380	440	500	540
4B	Elbow to elbow width	385	450	515	635
4C	Hip width, sitting	320	365	410	450

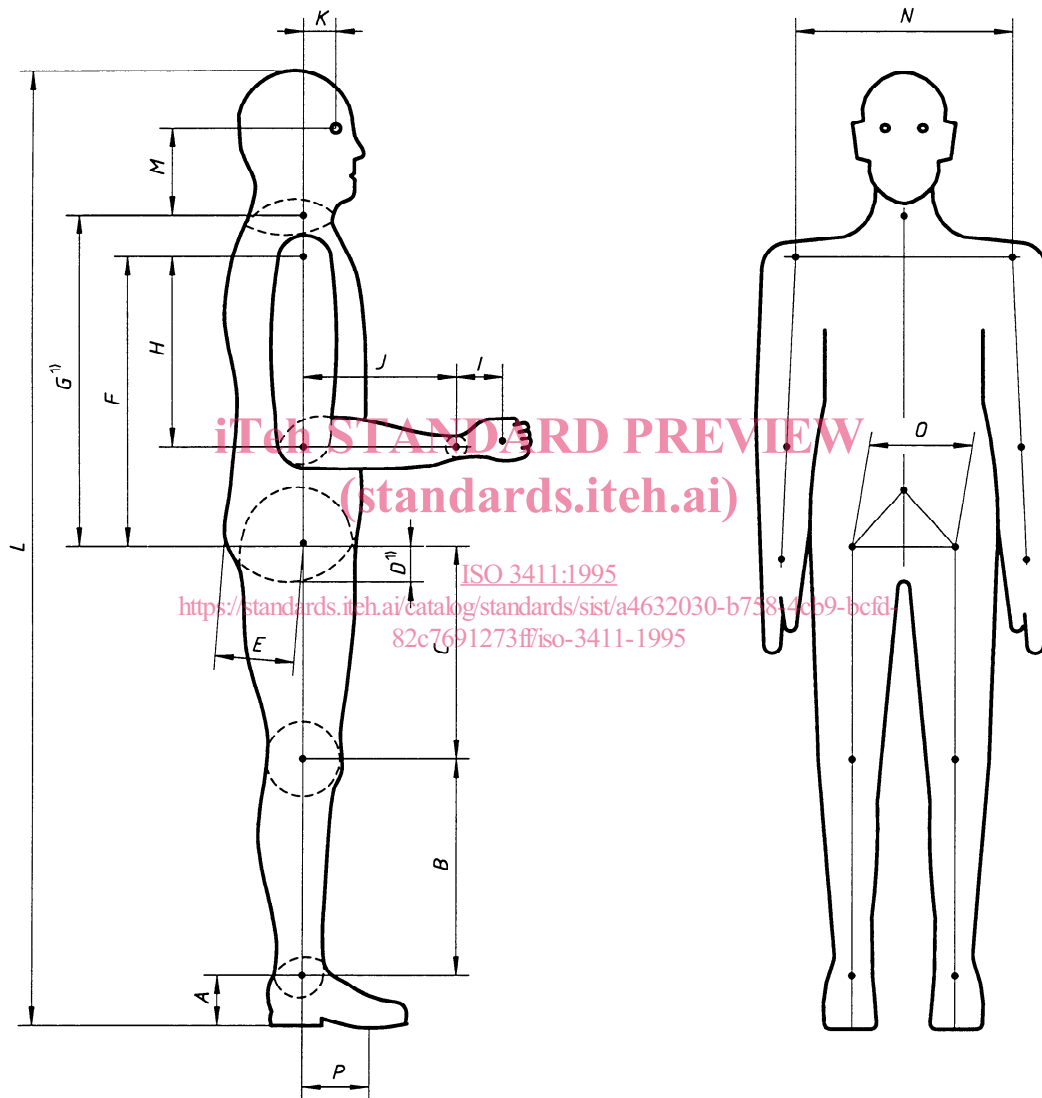
1) Add approximately 50 mm for protective helmet, if required, except for the large operator (arctic clothes).

2) See 4.3.

3) The dimension for hand width does not include the thumb.

4) The dimension for hand thickness relates to the thickness at the base of the fingers, not the palm thickness.

Figure 3 — Dimensions of sitting clothed operator



1) See table, footnote 1).



Dimensions in millimetres

Reference	Designation	Small operator	Medium operator	Large operator
<i>A</i>	Ankle height (with shoes)	98	109	119
<i>B</i>	Leg length	367	406	445
<i>C</i>	Thigh length	372	412	452
<i>D</i>	Hip point to buttock (vertical) <sup>1)</sup>	80	88	97
<i>E</i>	Hip point to buttock (fore-aft)	113	125	137
<i>F</i>	Trunk length	396	438	480
<i>G</i>	Hip point to neck pivot <sup>1)</sup>	481	533	584
<i>H</i>	Upper arm length	247	274	300
<i>I</i>	Wrist to control grasp	105	116	127
<i>J</i>	Forearm length	220	244	267
<i>K</i>	Eye to body centreline	71	78	86
<i>L</i>	Stature (with shoes)	1 550	1 715	1 880
<i>M</i>	Eye level to neck pivot	133	148	162
<i>N</i>	Shoulder pivot width	310	343	376
<i>O</i>	Hip pivot width	152	169	185
<i>P</i>	Ankle to pedal force point	124	137	150

NOTE — These dimensions are based on ISO 6682:1986, annex A.

1) For the operator in the sitting position.

Figure 4 — Body pivot dimensions