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SAE J154 MAR79

**Operator Enclosures
Human Factor Design
Considerations**

SAE Recommended Practice
Revised March 1979

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Ø OPERATOR ENCLOSURES HUMAN FACTOR DESIGN CONSIDERATIONS

1. PURPOSE:

This recommended practice is intended as a guide for determining the minimum normal operating space envelope around an operator for operator enclosures (cabs, ROPS, etc.) of the type used on machines in categories for construction, general purpose industrial, and forestry as defined in SAE J1116 (April, 1978).

2. SCOPE:

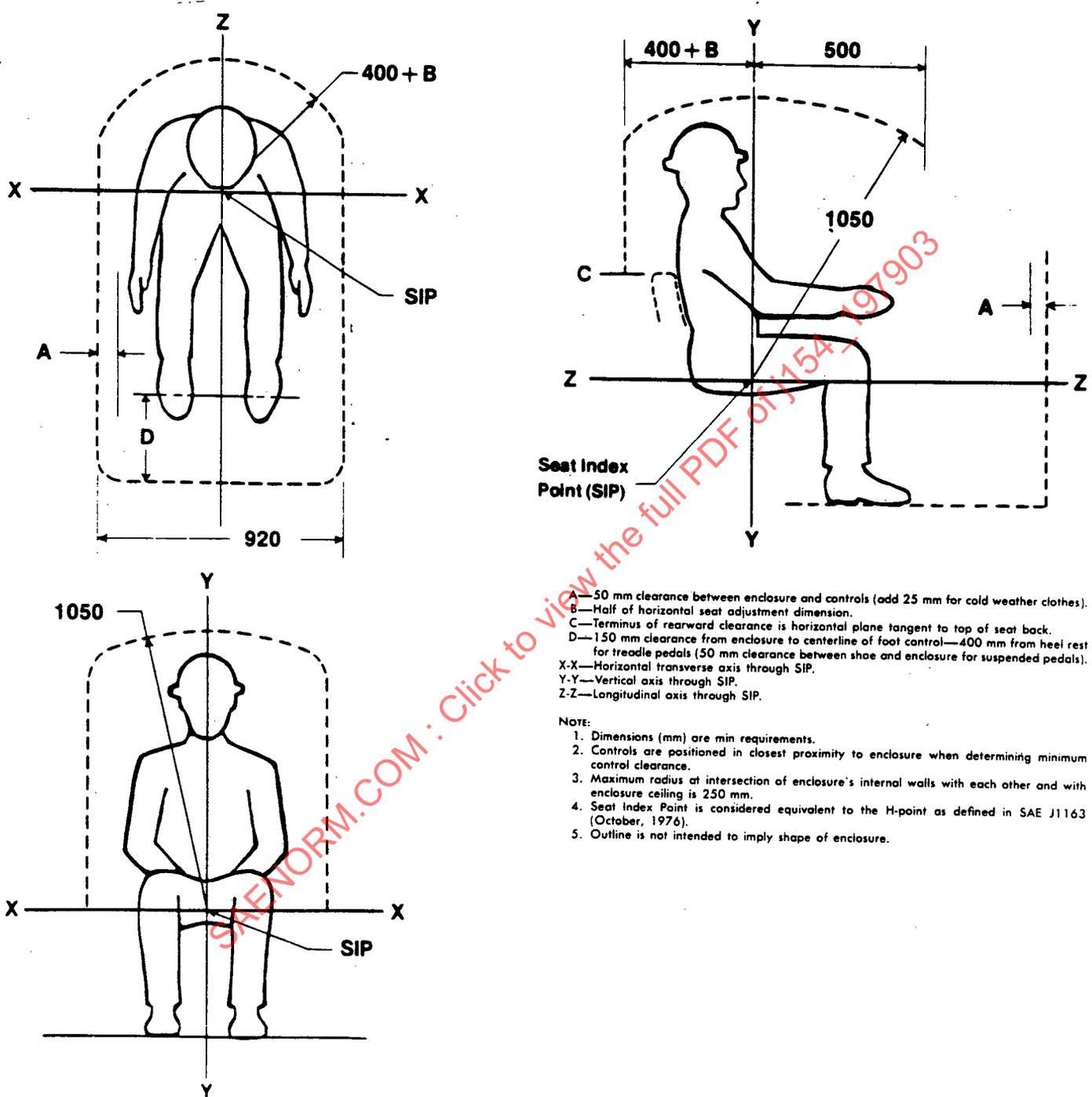
- 2.1 This recommended practice is limited to enclosure configurations in which the operator sits or stands as illustrated in Figs. 1 and 2 during mobile machine operations.

3. REQUIREMENTS:

- 3.1 The minimum space envelope around the operator should be as defined in Fig. 1 for sitting or Fig. 2 for standing enclosures. The operator will normally be centered in the enclosure but may be offset providing the minimum distance from the operator's centerline to the side of the enclosure is not less than 380 mm.
- 3.2 Operator enclosure minimum space envelope may be smaller than specified in 3.1 if it can be demonstrated that equivalent or greater performance is provided than obtained in this recommended practice.
- 3.3 It is recognized that particular types of machines such as small skid steer machines and small excavators may necessitate use of a space envelope smaller than the minimum indicated by this recommended practice. It is recommended that on these special machines the internal cab width not be less than 750 mm.

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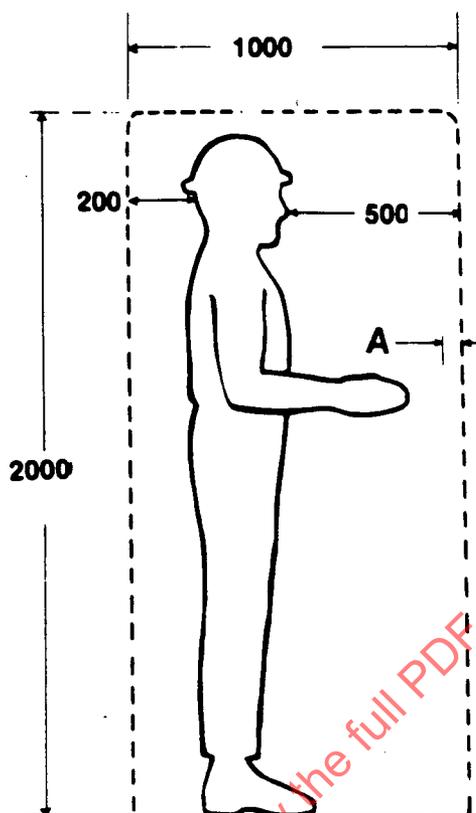
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A—50 mm clearance between enclosure and controls (add 25 mm for cold weather clothes).
 B—Half of horizontal seat adjustment dimension.
 C—Terminus of rearward clearance is horizontal plane tangent to top of seat back.
 D—150 mm clearance from enclosure to centerline of foot control—400 mm from heel rest for treadle pedals (50 mm clearance between shoe and enclosure for suspended pedals).
 X-X—Horizontal transverse axis through SIP.
 Y-Y—Vertical axis through SIP.
 Z-Z—Longitudinal axis through SIP.

- NOTE:
1. Dimensions (mm) are min requirements.
 2. Controls are positioned in closest proximity to enclosure when determining minimum control clearance.
 3. Maximum radius at intersection of enclosure's internal walls with each other and with enclosure ceiling is 250 mm.
 4. Seat Index Point is considered equivalent to the H-point as defined in SAE J1163 (October, 1976).
 5. Outline is not intended to imply shape of enclosure.

FIGURE 1 - Operator Minimum Interior Space Envelope
 For Sitting Enclosure
 (95th Percentile U.S. Male, See SAE J833a (June, 1974))



- A—50 mm clearance between enclosure and controls (add 25 mm for cold weather clothes).
1. All notes for sit down enclosure (Fig. 1) apply to standing enclosure.
 2. Enclosure width dimension is same as sit down enclosure width (Fig. 1).
 3. Clearance between foot controls and standing enclosure is same as sit down enclosure clearance (Fig. 1).

FIGURE 2 - Operator Minimum Interior Space Envelope
For Standing Enclosure
(95th Percentile U.S. Male, See SAE J833a (June, 1974))

RATIONALE:

The revisions to J154 primarily refine the document to reflect industry experience and to better define the criteria. The internal enclosure height, the relationship of the operator to the side of the enclosure, and the method of dimensioning clearances are the significant changes. Also eliminated is the reference to rough terrain as a factor of consideration.

Internal Height

The J154 internal enclosure height specification resulted in over 200 mm (8 in) head clearance for a 95th percentile erect sitting American male wearing a hard hat. Customer experienced satisfactory performance from enclosures with significantly less internal clearance than that specified in J154. An evaluation of the human engineering factors also proved that as a minimum performance criteria, the J154 internal clearance was excessive.

The following factors were determined to arrive at an acceptable minimum internal enclosure height for a 95th percentile American male:

- | | |
|--|------------------------|
| 1. Seating height of large operator (from H-point to top of head): | 870 mm (34.2 in) |
| 2. Safety hat: | 50 mm (2.0 in) |
| 3. Seat adjustment and suspension travel above its mid-range: | 75 mm (3.0 in) |
| 4. Minimum operator bounce: | <u>50 mm (2.0 in)</u> |
| | 1045 mm (41.2 in) |

The 1045 mm (41.2 in) dimension was rounded off to 1050 mm (41.3 in) as the recommended minimum clearance from the H-point to the enclosure ceiling. Clearance is provided for safety hats since construction and industrial machine operators are generally required to wear them. Suspension seats are available as standard or as an option on many current machines and it is anticipated their use will greatly increase in the near future, justifying adjustment and suspension travel allowance being included as a permanent part of the minimum height requirement. The 75 mm (3 in) allowance considers vertical adjustments and suspension travel above the seat's mid-range position.

Additionally, a clearance of 50 mm (2 in) was considered as the minimum allowance for an erect sitting person beyond the 75 mm (3 in) allowed for vertical adjustment and suspension bounce. The actual clearance will be 85 to 100 mm (3.5 to 4 in) since a person does not normally sit or bounce in a rigid erect position. Seat belts further help restrain a person in a bounce situation. The minimum clearance for a 95th percentile U.S. male operator sitting normally in a seat with the seat adjusted to its mid-range vertical position is 160 to 175 mm (6 to 7 in).

Measurement Method

The H-point/Seat Index Point (SIP) as specified in J1163 makes an appropriate reference point rather than locating the seat in its extreme position as specified in J154. The difficulty in determining head and shoulder clearance can be resolved by referencing the clearance from a vertical line through the H-point/SIP. In this revision dimensions are referenced from the H-point/SIP.

Head and Shoulder Clearance

It is assumed that the seat has a nominal 10 degree rake angle. The 400 mm (16 in) dimension plus half of the horizontal seat adjustment provides approximately 200 mm (8 in) minimum back of the head and shoulder clearance for a 95th percentile male operator.

Cab Width

The overall minimum cab width recommendation did not change. Allowance is provided for offsetting the operator with relationship to the centerline of the minimum space envelope. In some situations, especially dumpers, the operator needs to look rearward out the side window. The offset provides for this requirement.

It is recognized that particular machines for certain types of applications require smaller space envelopes than specified in this document. It is recommended, where possible, that the minimum width for these particular machines not be less than 750 mm since this is the minimum width that a 95th percentile male in winter clothes can comfortably operate for a reasonable length of time, providing controls are located in front of the operator. Some applications will require machines with widths less than 750 mm which will necessitate use of short operating intervals or smaller operators.

The minimum space envelope is based primarily on anthropometric considerations. 3.2 was added to permit deviation from the specified minimum if it could be demonstrated for a specific machine that its operator enclosure provided equivalent or superior performance than obtained by the minimum specified enclosure.