SAE International™ SURFACE VEHICLE STANDARD

SAE J898/ ISO 6682

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Control Locations for Off-Road Work Machines

***Foreword*—**This document has been replaced by J/ISO 6682.

1. ***Scope*—**This SAE Standard applies to Construction, General Purpose Industrial, Agricultural, Forestry, and Specialized Mining categories of off-road, self-propelled work machines, as defined in SAE J1116. Powered industrial trucks and agricultural equipment, other than the basic agricultural tractor, are excluded from the scope of this document. The document defines positions for convenient placement of hand- and foot-operated controls derived from the overlapping reach capability of large and small operators. The large operator approximates the 95th percentile male, and small operator approximates the 5th percentile female of the U.S. population.

1.1 Purpose—This document defines zones in which controls used by a seated operator would ordinarily be placed, and is intended as a guide for the design of the operator compartment controls. Constraints peculiar to individual machine or user applications may require modification to these defined zones.

The established zones are based upon singular reach capability: appropriate consideration must be made for effort, displacement, and simultaneous operation of two or more controls.

2. ***References***

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. Unless otherwise specified, the latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1116 JUN86—Categories of Off-Highway Self-Propelled Work Machines
SAE J1163 JAN80—Method for Determining Operator Seat Location on Agricultural and Construction Machines

3. ***Definitions***

3.1 SIP—Seat Index Point as defined in SAE J1163 JAN80.

3.2 Control Displacement—The travel or movement of a control through its operational range.

3.3 Control Location—The positions of a control including the corresponding displacement, defined from the SIP.

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3.4 Primary Controls—Controls whose use is frequently or continuously required to maintain operational control of the machine or its functions, such as:

3.4.1 MACHINE CONTROLS—Transmissions, brakes, steering, engine speed, etc.

3.4.2 WORKING TOOL CONTROLS—Blade, bucket, ripper, etc.

3.5 Secondary Controls—Controls that are infrequently used by the operator such as: lights, windshield wipers, starter, heater, air conditioner, etc.

3.6 Zones of Comfort—Preferred control location zones for primary hand- and foot-operated controls. Both large and small operators should be able to comfortably and quickly reach controls in these zones.

3.7 Zones of Reach—Control location zones for secondary hand- and foot-operated controls. Both large and small operators should be able to reach controls in these zones from the seated positions, but the operator may be required to rotate, lean forward, or to each side.

3.8 XYZ Coordinate System—Coordinate system used to define the control zone locations:

3.8.1 Origin at the SIP.

3.8.2 X-AXIS—Fore-aft, positive to the front of the SIP.

3.8.3 Y AXIS—Lateral, positive to the right of the SIP.

3.8.4 Z AXIS—Vertical, positive upward from the SIP.

3.9 Flexion—Movement that changes the angle between body parts.

3.10 Abduction—Movement in a plane normal to the plane of flexion and directed away from the mid-axis (XZ plane) of the body.

3.11 Adduction—Movement in a plane normal to the plane of flexion and directed towards or past the mid-axis (XZ plane) of the body.

3.12 Circumduction—Movement about an axis that circumscribes a cone.

***4. General Conditions*—**The following conditions were utilized to define the control zones:

4.1 The seat back cushion has a 10 degree nominal angle aft of the vertical and a width of 500 mm.

4.2 The seat has a fore and aft adjustment range of approximately 150 mm. The small operator adjusts the seat to the most forward position, and large operator adjusts the seat to the most rearward position.

4.3 Both large and small operators position the seat at the nominal vertical adjustment. Vertical seat adjustment is used by individual operators to account for the anthropometric variations: long legs but short arms; long trunk but short legs, etc.

4.4 Large and small operators are defined by body pivot dimensions listed in Table 1.

TABLE 1—SUMMARY—BODY PIVOT DIMENSION

Figure 1 Reference	Body Elements	Large Operator	Small Operator
SH	Shoulder-hip	480	396
HK	Hip-knee	452	372
KA	Knee-ankle	445	367
AA'	Ankle-shoe sole	119	98
A'P	Ankle-pedal (When A_1 = 90 degrees)	150	124
SE	Shoulder-elbow	300	247
EW	Elbow-wrist	267	220
EHg	Elbow-hand grasp	394	325
A'T	Ankle-tow (when A_1 = 90 degrees)	243	200
H_1H_2	Hip-hip (lateral)	185	125
S_1S_2	Shoulder-shoulder (lateral)	376	310

Dimension in mm

4.5 Large and small operators are capable of the range of movement angles defined in Table 2.

TABLE 2—SUMMARY—RANGE OF MOVEMENT ANGLES

Figure 1 Reference	Angle (Right Side Joint)	Movement	Angle (degrees) Comfort	Angle (degrees) Max
A_1	Seat Back Angle	Aft of Vertical	10	5 to 15
A_2	Trunk	Abduction	0	20 (Left or Right)
A_3	Hip	Flexion	75 to 100	60 to 110
A_4	Hip	Adduction	10	10
A_5	Hip	Abduction	22	30
A_6	Knee	Flexion Adduction	75 to 160	75 to 170
A_7	Ankle	Flexion	85 to 108	78 to 115
A_8	Shoulder	Flexion	–35 to 85	–50 to 180
A_9	Shoulder	Adduction	20	20
A_{10}	Shoulder	Abduction	70	120
A_{11}	Clavicle	Circumduction	20	20
A_{12}	Elbow	Flexion	60 to 180	45 to 180

4.6 Control location zones are defined by the common reach zones for large and small operator under the conditions in 4.1, 4.2, 4.3, 4.4, and 4.5. The profile of the control zones has been established by overlaying the reach dimensions of the large operator when the seat is positioned full aft (75 mm aft of SIP) with that of the small operator when the seat is positioned full forward (75 mm forward of the SIP). The recommended zone boundary is the most restrictive of these two conditions.

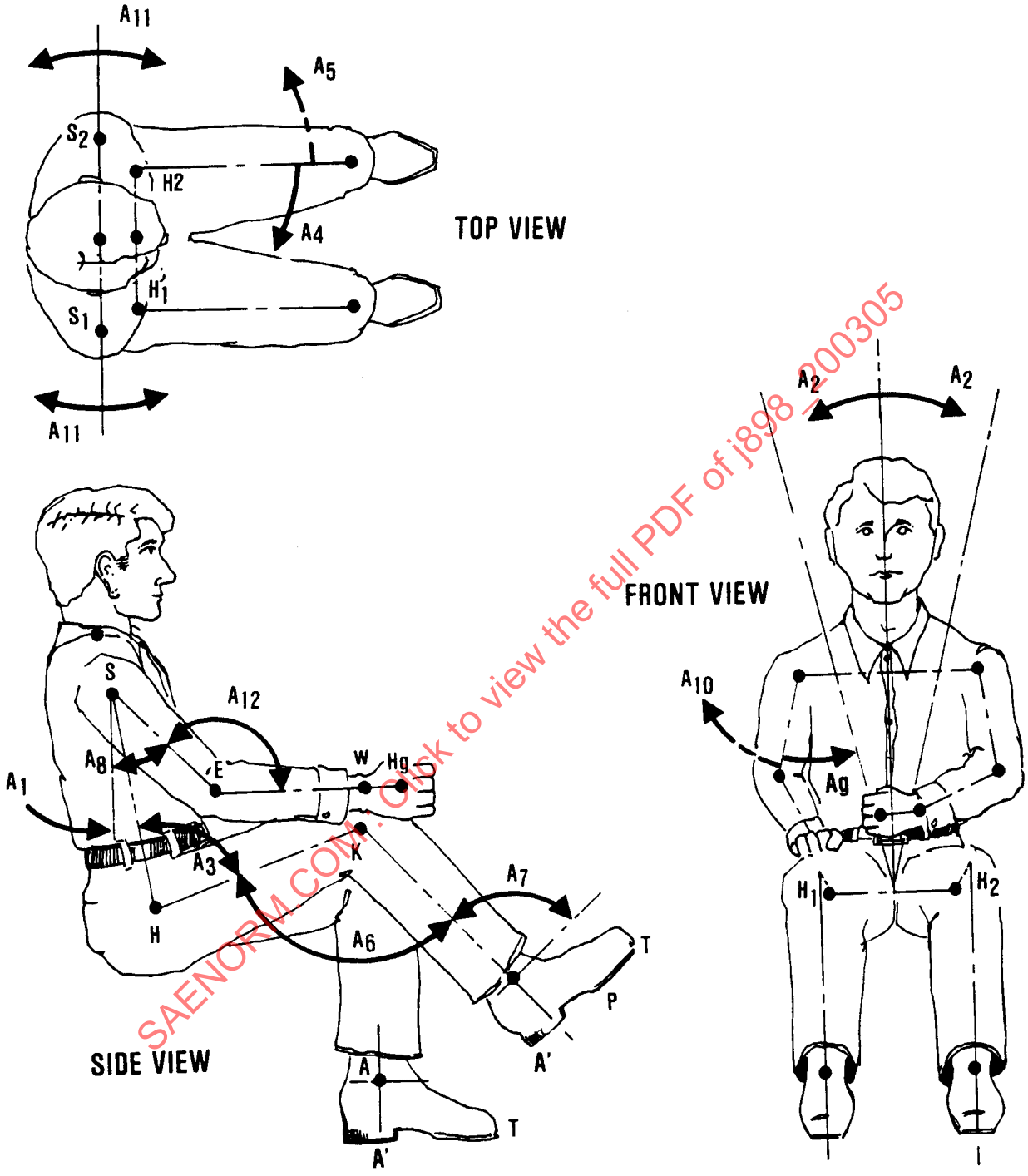


FIGURE 1—SCHEMATIC OF BODY PIVOT DIMENSION NOMENCLATURE

4.7 These control location zones assume fixed controls and that fitment to the range of large and small operators is accomplished by seat adjustment only. However, adjustment for some or all of the necessary range could be accomplished by adjusting the control itself; i.e., telescoping or adjustable (angle) steering wheel, brake pedals, etc.

5. Control Location Zones

5.1 Zones of comfort and zones of reach for hand and foot controls are determined in relation to the SIP and are shown in Figures 1, 2, and 3. The zones will be affected if the seat back angle exceeds ±5 degrees variation from 10 degrees aft of the vertical or if the seat back cushion width exceeds 550 mm.

5.2 The zones of comfort and reach have been established assuming the body is free to move within the range of angles defined in Table 2; consequently, if placement of any control or other constraints to body movement are included in the design, the boundary of the zone must be modified accordingly.

6. Location of Controls

6.1 Figures 2, 3, and 4 shall be used to define control location zones for machines having 150 mm fore-aft seat adjustment. The figures shall be used by positioning the intersections of the vertical (Z), longitudinal (X), and transverse (Y) axis at the SIP location on the machine.

6.2 Control locations for machines that have between 100 to 150 mm fore-aft seat adjustment can be derived:

6.2.1 Use hand control location zones defined in Figures 2, 3, and 4.

6.2.2 Narrow the foot control location zones defined in Figures 2, 3, and 4 by adding one-half the difference in seat adjustment from the X coordinates of the boundaries closest to the SIP and by subtracting half the difference in seat adjustment from the X coordinates of the boundaries farthest from the SIP.

6.3 Primary controls, including their displacements, should be located within the zone of comfort. Secondary controls to be operated from the seated position should be within the zone of reach.

6.3.1 If a wheel is used for steering, at least 180 degrees of its arc should be located within the zone of comfort.

6.4 Controls should be designed to be actuated within the appropriate zones to eliminate potential interference between the body limbs when simultaneously operating hand and foot controls.

6.5 The zone of comfort for hand controls may be rotated up to 30 degrees about a vertical axis through the SIP for locating rear equipment controls that are used while the operator is turned in the seat.

6.6 The zone of comfort and zone of reach for hand controls are based on the hand grasp point; the zone boundaries may be extended 75 mm when fingertip controls are utilized.

6.7 The zone of comfort and zone of reach for foot controls is based upon pedal actuation by the ball of the foot; heel actuated controls may be up to 200 mm aft of the zone boundary.

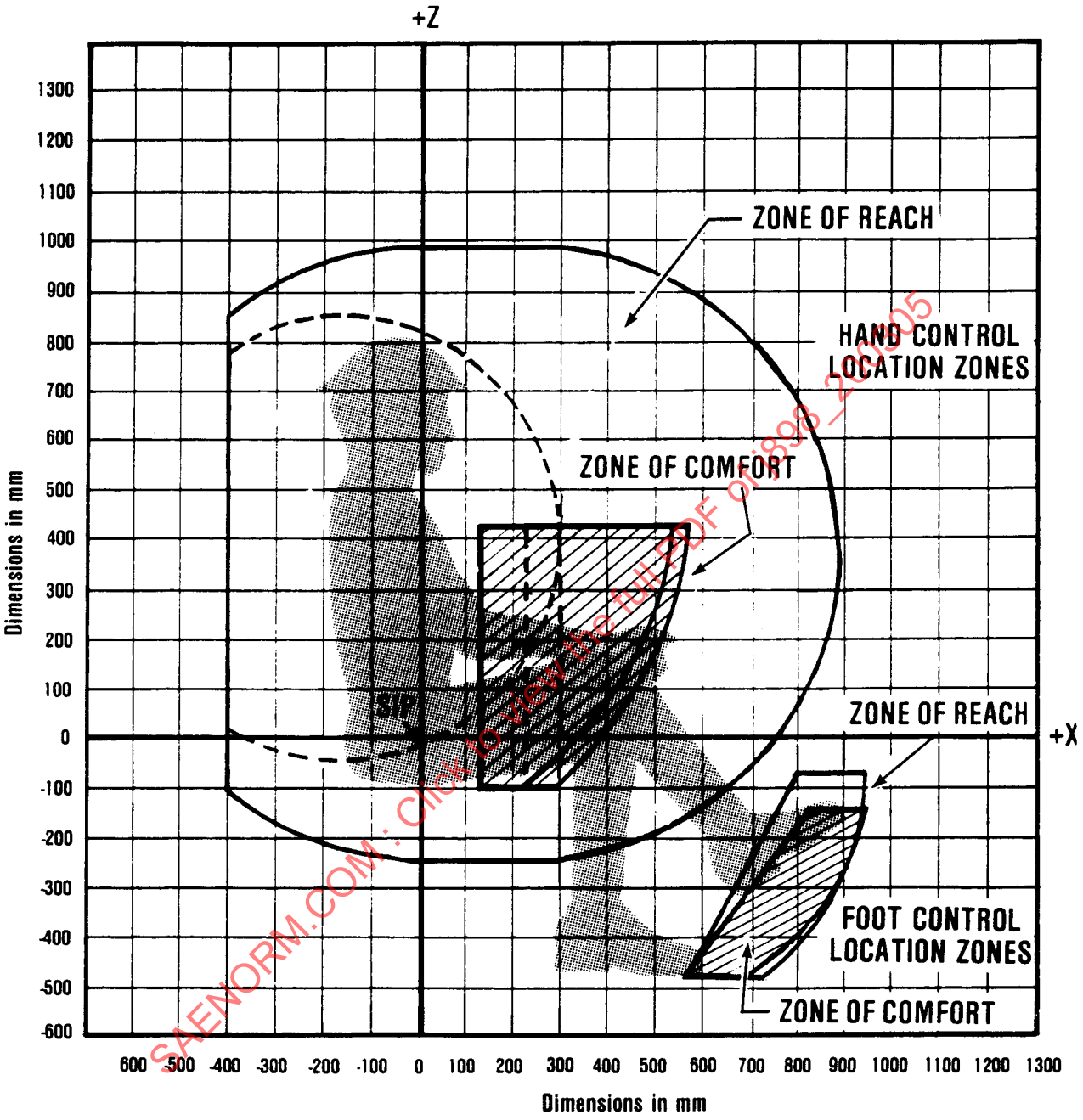


FIGURE2—SIDE VIEW—ZONES OF COMFORT AND REACH (NOTE—AVERAGE OPERATOR IS SHOWN WITH SEAT ADJUSTED TO THE MID-RANGE POSITION.)

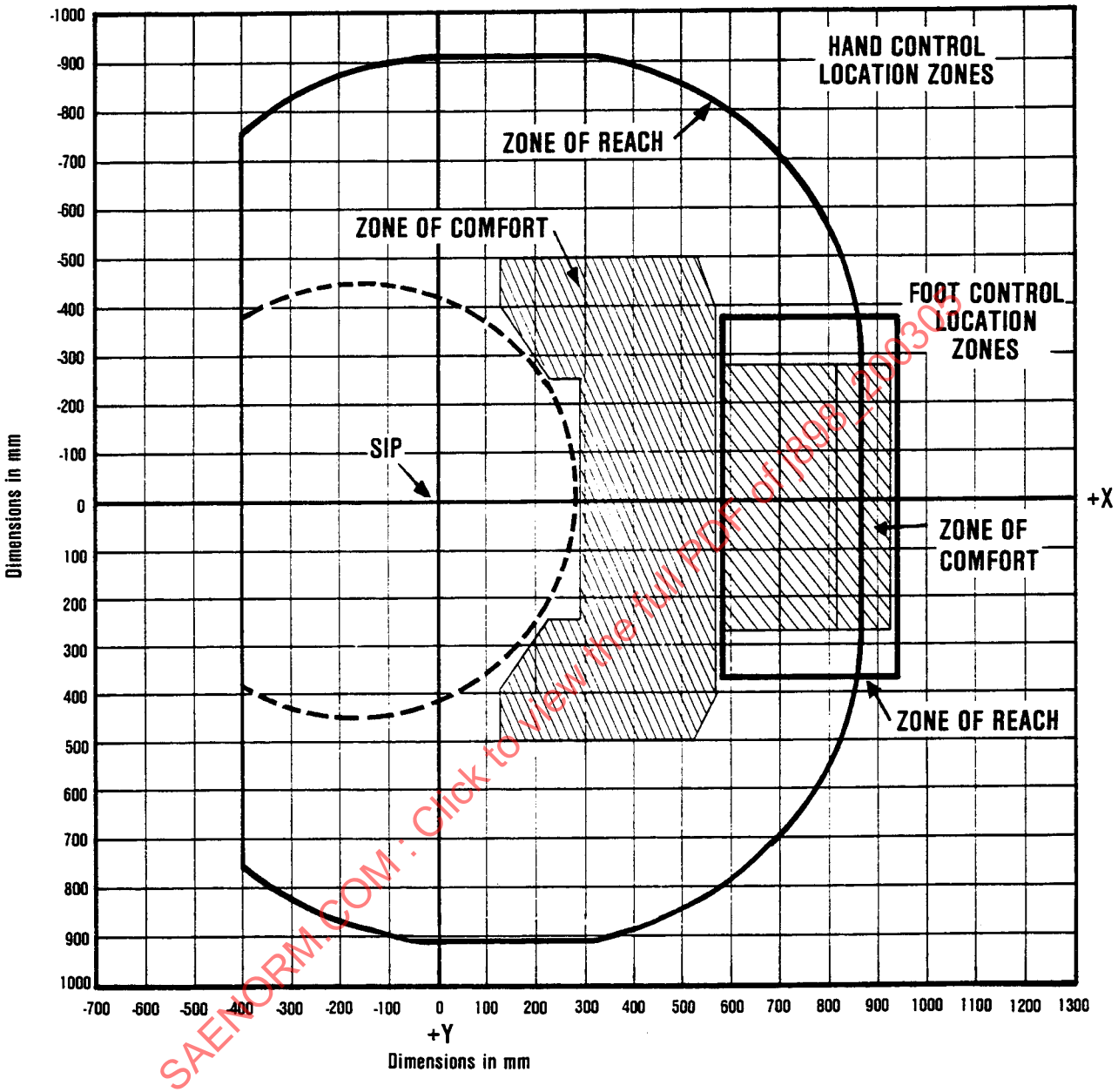


FIGURE 3—TOP VIEW—ZONES OF COMFORT AND REACH

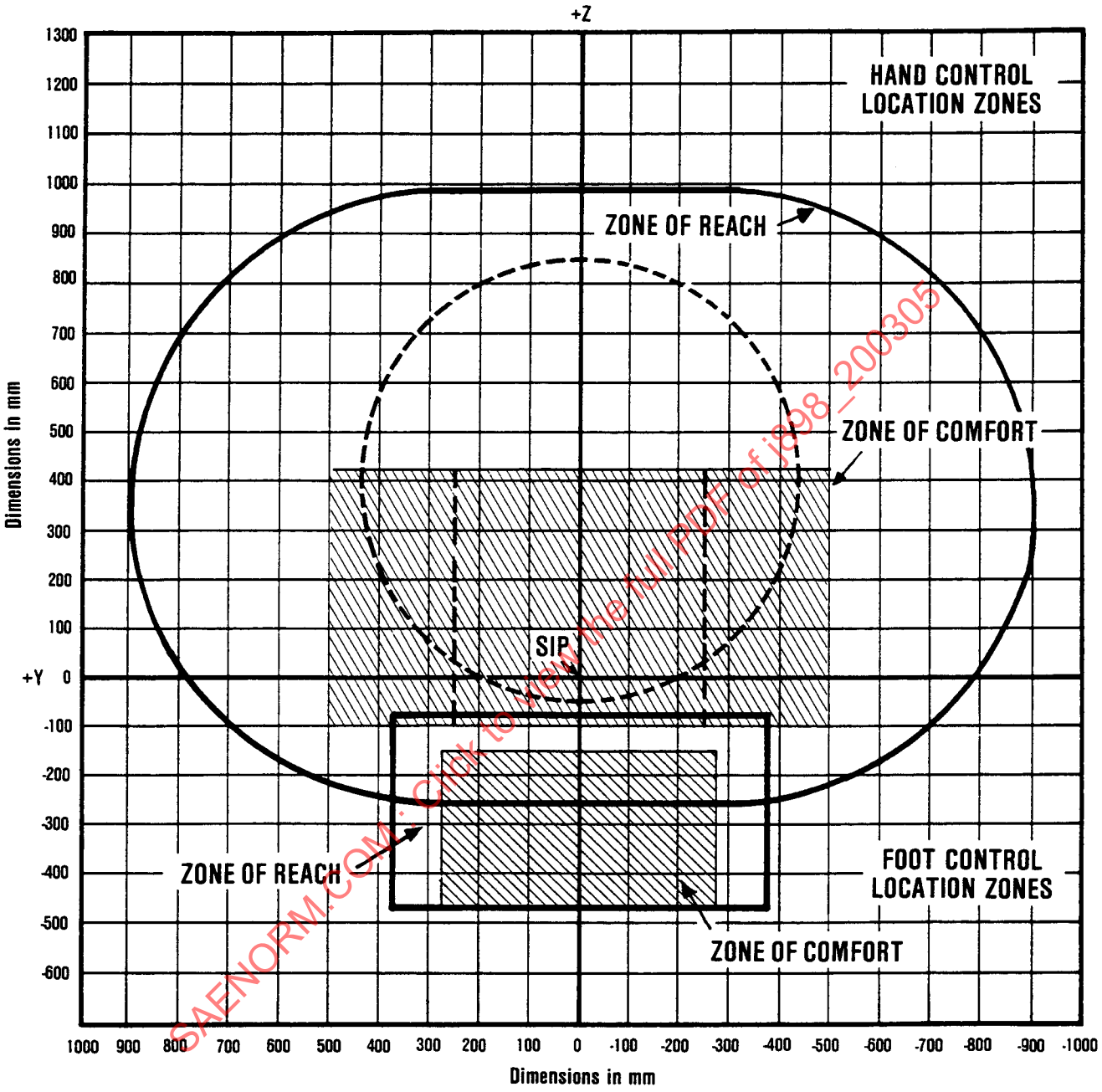


FIGURE 4—FRONT VIEW—ZONES OF COMFORT AND REACH

PREPARED BY THE SAE HUMAN FACTORS MACHINE CONTROLS COMMITTEE

APPENDIX A

SUMMARY OF COORDINATES FOR DEFINING CONTROL LOCATION ZONES

A.1 Coordinates to define the zone of comfort and zone of reach for control location are summarized in Tables A1, A2, A3, and A4. Since the control location zones are symmetrical about the XZ plane, only one-half is defined. The other half can be defined by changing the sign of the Y coordinates.

The control location zones are defined by coordinates for the corners of planar surfaces, and by the center of curvature coordinates and the radii of spherical and cylindrical surfaces. The zone of reach for hand controls is defined by planar and cylindrical boundaries that are tangential to the spherical surfaces defined in Table A2.

TABLE A1—COORDINATES FOR ZONE OF COMFORT HAND CONTROL LOCATION ZONE

Center of Curvature[1] S1 Point[1]	(X,Y,Z) Coordinates (–159, 188, 476) (X, Y, Z) Coordinates	Radius R_1 = 734 R_2 = 691
A_1	(132, 500, 425)	
A_2	(132, 500, –100)	
B_1	(132, 400, 425)	
B_2	(132, 400, –100)	
C_1	(230, 250, 425)	
C_2	(230, 250, –100)	
D_1	(296, 250, 425)	
D_2	(296, 250, –100)	
E_1	(530, 500, 425)	
E_2	(221, 500, –100)	
F_1	(573, 400, 425)	
F_2	(296, 400, –100)	

1. Refer to Figures A1, A2, and A3.

TABLE A2—COORDINATES FOR ZONE OF REACH—HAND CONTROL LOCATION ZONE

	(X, Y, Z) Coordinates	Radius
Center of Curvature[1]		
SS_1	(6, 283, 368)	R_3 = 625
SS_2	(245, 283, 368)	R_3 = 625
SS_1	(–160, 0, 400)	R_4 = 450
Point[1]	(X, Y, Z) Coordinates	
G	(X = –400)	

1. Refer to Figures A1, A2, and A3.

TABLE A3—COORDINATES FOR ZONE OF COMFORT—FOOT CONTROL LOCATION ZONE

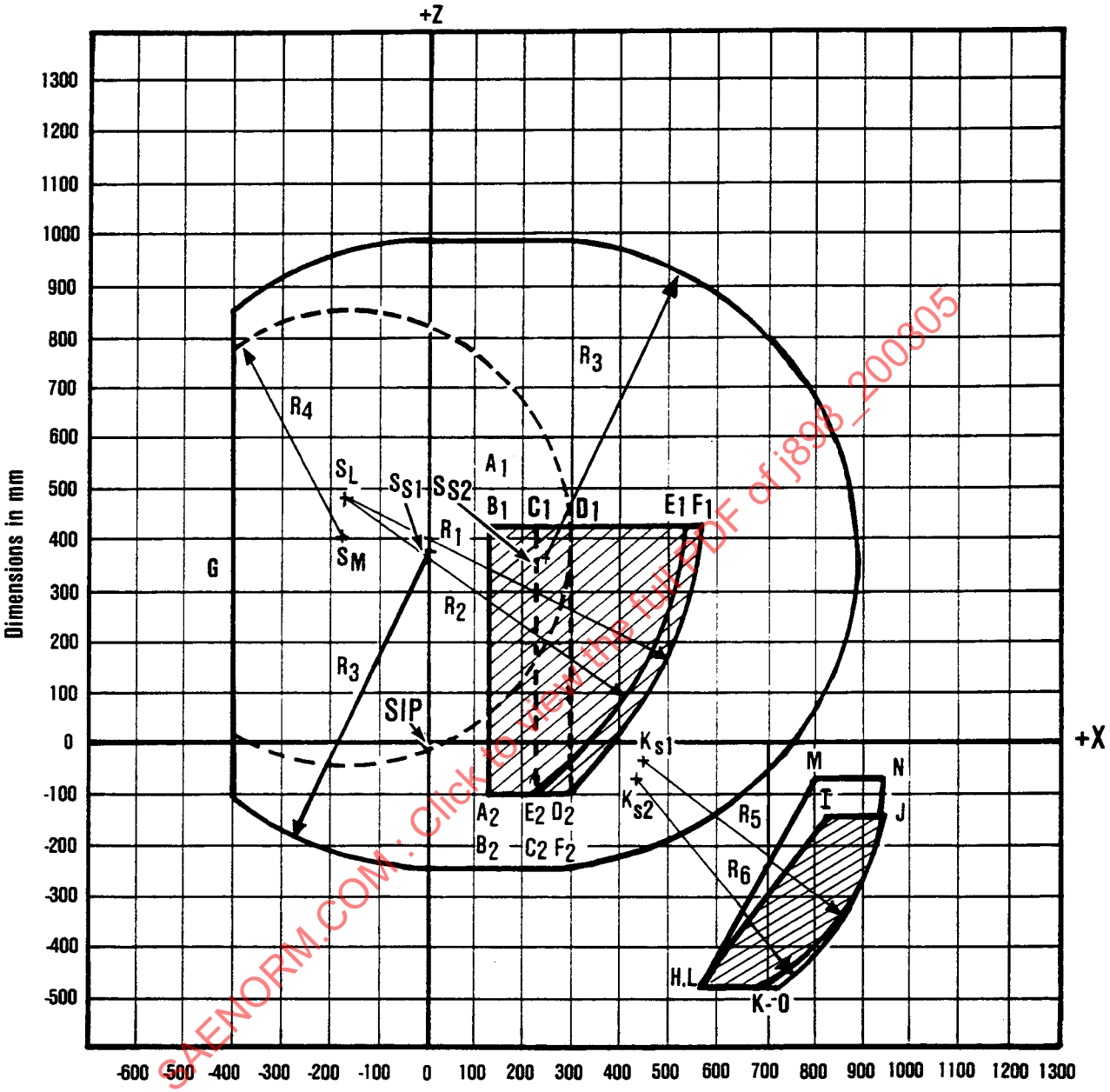
Center of Curvature[1]	(X, Y, Z) Coordinates	Radius
K_{s1}	(446, –75, –32)	R_4 = 500
Point[1]	(X, Y, Z) Coordinates	
H	(581, –275, –470	
I	(820, –275, –150)	
J	(932, –275, –150)	
K	(687, –275, –470)	

1. Refer to Figures A1, A2, and A3.

TABLE A4—COORDINATES FOR ZONE OF REACH—FOOT CONTROL LOCATION ZONE

Center of Curvature[1]	(X, Y, Z) Coordinates	Radius
K_{s2}	(441, –75, –65)	R_4 = 500
Point[1]	(X, Y, Z) Coordinates	
L	(581, –375, –470)	
M	(796, –375, –75)	
N	(941, –375, –75)	
O	(734, –375, –470)	

1. Refer to Figures A1, A2, and A3.



Dimensions are in mm

FIGURE A1—SIDE VIEW COORDINATES FOR ZONES OF COMFORT AND REACH