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Anthropomorphic Test Device for Use in Dynamic Testing of Motor Vehicles —SAE J963

SAE Recommended Practice
Editorial change October 1977

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ANTHROPOMORPHIC TEST DEVICE FOR USE IN DYNAMIC TESTING OF MOTOR VEHICLES—SAE J963 SAE Recommended Practice

Report of Automotive Safety Committee approved June 1968. Editorial change October 1977. *Cancelled 1979*

1. **Scope**—This SAE Recommended Practice describes and defines a standard anthropomorphic test device for use in both actual and simulated vehicle crash impact tests. This test device is designed to be used in the evaluation of vehicle interiors and restraint systems for vehicle occupants during various impact conditions. The structural characteristics of this device simulate the basic human body components only in size, shape, mass, and kinematics. The device has no capability to simulate human physiological functions or to measure simulated physiological responses.

This report establishes the basic design criteria for component weights, weight distribution, dimensions, and motion capabilities of the device. Specific performance requirements for the device are given only where data are available. This SAE Recommended Practice reflects the current state-of-the-art in this regard. Additional sizes of anthropomorphic test devices are under development. It is intended that the content of this report will be subject to continuing review and will be revised as additional data, experience, and new technology warrant.

Other dynamic anthropomorphic test devices are described in SAE J9444 and SAE J984.

2. **Purpose**—The test device described herein is for use in the following evaluation programs:

2.1 Design developments of the vehicle interiors for energy absorption during impacts.

2.2 Correlation of data obtained from various types of test programs and facilities and from different testing agencies.

3. **General Description**—The standard anthropomorphic test device shall have 50th percentile component size and weight characteristics appropriate to the adult male as defined in Tables 1 and 2 and Figs. 1-3.

The test device(s) shall be capable of receiving instrumentation, and when so equipped shall have a range of component kinematic patterns similar to those of an adult human male as defined in Table 2 and Figs. 2 and 3. The head, torso, arm, and leg components of the test device shall have characteristics to respond kinematically during impact. These shall include the functional mechanical equivalents of the spinal column, rib cage and sternum, pelvis, joint articulations at the neck, shoulder, elbow, wrist, hip, knee, and ankle, and exterior component coverings.

4. Component or Segment Requirements

4.1 **Head**—The head shall consist of composite structures that are geometrically similar to the human head. The basic structure shall have an

accessible internal ballast and instrumentation cavity and a pliable external covering with appropriate surface contours. The connecting and supporting structure for the head shall have the capability of maintaining an erect head position up to a horizontal acceleration of 2g.

4.2 **Torso**—The connecting and supporting structures shall allow the test device to maintain a simulated sitting position similar to that of a human occupant of a vehicle. The design of these connecting and supporting structures shall be such that during acceleration, the lap belt restrained test device will develop a forward jackknifing motion.

4.2.1 **TORSO: SHOULDER SECTIONS**—The shoulder structures shall be geometrically and functionally similar to the human shoulder complex.

4.2.2 **THORAX: SPRING RATE**—The thorax dynamic impact load—deflection spring rate shall be 900 ± 100 lb/in. This spring rate is determined by dividing the force applied to the thorax by the deflection within the range of 0.75-1.0 in.

4.2.2.1 **Determination of Thorax Spring Rate**—The dynamic spring rate of the thorax may be determined using a complete test device with the thorax assembly only. When the complete test device is evaluated, a simulated forward impact of a seated occupant is used. When only the thorax assembly is used, its weight along with mounting fixture shall be 45 ± 5 lb.

4.2.2.2 **Impact Target**—The impact target shall be 6 in. in diameter with an optional 0.5 in. covering of padding material. The target shall be fixed to a stationary load cell.

4.2.2.3 **Location of Center of Target**—The center of impact on the sternum shall be on the vertical centerline at a point located 18 ± 0.5 in. from the top of the head of an erect test device.

4.2.2.4 **Alignment of Impact Target**—The impact target and load cell assembly shall be aligned so that the major force axis is normal to the impacting sternum.

4.2.2.5 **Impact Velocity**—Impact velocity is 22 ± 7 ft/sec.

4.2.2.6 **Sternum Deflection Measurement**—The measured deflection shall be a measure of sternum movement relative to the spine only.

4.2.3 **TORSO: ABDOMINAL SECTION**—The simulated abdominal structure shall be soft and pliable.

4.2.4 **TORSO: PELVIC SECTION**—The pelvic structure shall be geometrically similar to the human pelvis.

4.3 **Arm and Leg Kinematics**—The range of motion of each extremity component is defined in Table 2 and Figs. 2 and 3. All joints shall have

TABLE 1—50th PERCENTILE MALE-BODY CENTERS OF GRAVITY, WEIGHTS AND DIMENSIONS (SEE FIG. 1)

Letter Designation	Title	Value	Reference	Letter Designation	Title	Value	Reference
	Centers of Gravity	in.			Segment Section Lines	in.	
A	Head (forward from backline of body)	4.0	1	AB	Head	9.3	1
B	Head (below top of head)	4.7	1	AC	Shoulders	16.9	1
C	Shoulders (forward of backline)	3.8	1	AD	Abdomen	25.1	1
D	Shoulders (below top of head)	14.1	1	K	Buttocks	10.0	1
E	Abdomen (forward of backline)	4.9	1	J	Shoulder—Elbow Length	14.1 ± 0.3	4
F	Abdomen (below top of head)	20.8	1	I	Elbow Rest Height (erect)	9.5 ± 0.5	3
G	Buttocks (forward of backline)	5.3	1	L	Popliteal Height	17.3 ± 0.2	3
H	Buttocks (below top of head)	31.2	1	M	Knee Height (sitting)	21.4 ± 0.3	3
	Head and trunk whole (forward of backline)	4.7	1	N	Buttock Popliteal Length	19.5 ± 0.3	3
	Head and trunk whole (below top of head)	22.7	1	O	Chest Depth	9.0 ± 0.4	2
				P	Buttock Knee Length	23.3 ± 0.3	3
	Segment Weights	lb		Q	Thigh Clearance	5.7 ± 0.3	3
	Head	11.2	1	R	Elbow-Finger Tip Length	18.7 ± 0.5	4
	Shoulders and Upper Thorax	17.3	1	S	Head Length	10.5 ± 0.2	2
	Lower Thorax and Upper Abdomen	23.0	1	T	Sitting Height (erect)	7.7 ± 0.2	2
	Lower Abdomen, Buttocks, and Upper Thighs	37.5	1	V	Shoulder Breadth	35.7 ± 0.5	3
	Upper Arm—each	5.4	1	W	Foot Breadth	17.9 ± 0.4	2
	Forearm—each	3.4	1	X	Head Circumference	22.5 ± 0.3	2
	Hand—each	1.4	1	Y	Chest Circumference	37.7 ± 1.0	4
	Upper Leg—each	17.6	1	Z	Waist Circumference (sitting)	33.0 ± 1.0	4
	Lower Leg—each	6.9	1	AA	Head Breadth	6.1 ± 0.2	2
	Foot—each	2.8	1				
	Total Test Device Weight	164 ± 3					

1. Experimental data submitted to the SAE Crash Test Dummy Task Force in a report by Alderson Research Laboratories, Inc., and reported in the minutes of April 1, 1968 meeting.

2. H. T. E. Hertzberg; E. Churchill, and G. S. Daniels, "Anthropometry of Flying Personnel, 1950." WADC Technical Report T. R. 52-321, Wright Air Development Center, September 1954.

3. "Weight, Height and Selected Body Dimensions of Adults—United States, 1960-1962." Report Series 11 Number 8, National Center for Health Statistics, Public Health Service, U. S.

Department of Health, Education and Welfare.

4. H. T. E. Hertzberg, Robert M. White, and the Crash Dummy Task Force of SAE Human Factors Subcommittee as reported in the Task Force minutes of Dec. 5, 1967 meeting. These values were developed utilizing adjusted military data on a judgment basis in the absence of existing published data on the civilian population.

5. Newman and White, "Reference Anthropometry of Army Men," Report 180, 1951.

TABLE 2—50th PERCENTILE MALE RANGES OF MOTIONS AND TERMINOLOGY

NOTE: The movements are described and measured from a referenced "anatomical position," which is defined as: "An erect standing posture with the palm surfaces of the hands positioned anteriorly (in supination)."
 There are some movements described in this list that may be best achieved mechanically by not duplicating the normal anatomical relationships of the skeletal components.

Letter Designation	Title	Angle, Deg	Letter Designation	Title	Angle, Deg	
B A C D	Head with Respect to Torso		R S U T V W	Thigh at Hip		
	Flexion	60 + 10		Flexion	120 min	
	Hyperextension	60 + 45		Hyperextension	45 + 10	
	Lateral Flexion	±40 ± 10		Medial Rotation	50 } +10	
E F AG	Shoulder Girdle with Respect to Torso	Rotation	±70 ± 10	Lateral Rotation	10	
		Anterior-Posterior Excursion	± 10	Adduction	50 } +10	
		Elevation	20 + 10	Abduction	10	
		Depression	10 + 10			
G H I J K L	Upper Arm at Shoulder	Adduction	0 } +10	Z Y AB AA	Foot at Ankle	
		Abduction	135 } +10		Plantar Flexion	45 } +10
		Medial Rotation	90 } +10		Dorsiflexion	30 } +10
		Lateral Rotation	0 } +10		Inversion	20 } +5
M	Forearm at Elbow	Flexion	180 } +10	Eversion	20 } +5	
		Flexion	60			
				Long Axis of Torso		
				Flexion	40 min	
P Q O N	Hand at Wrist	Palmar Flexion	90 + 10	Hyperextension	30 + 5	
		Dorsiflexion	60 + 10	Lateral Flexion	35 + 10	
		Pronation	180 ± 10	Rotation	35 + 10	
		Supination				

References:
 1. Reference 4, Table 1.

2. Gianville and Kreezer, "The Maximum Amplitude and Velocity of Joint Movements in Normal Male Adults." Human Biology Vol. 9, 1937, pp 197-211.

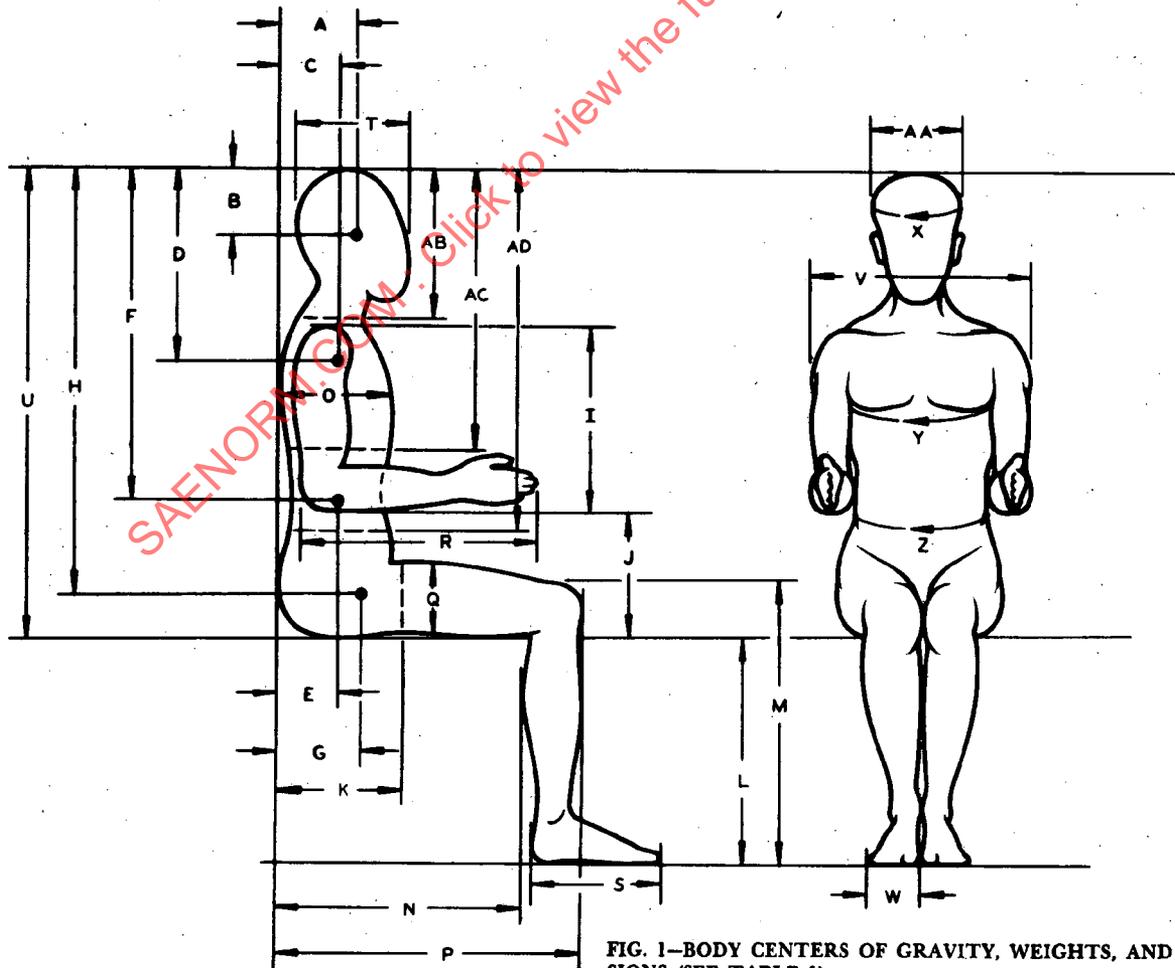


FIG. 1—BODY CENTERS OF GRAVITY, WEIGHTS, AND DIMENSIONS (SEE TABLE 1)

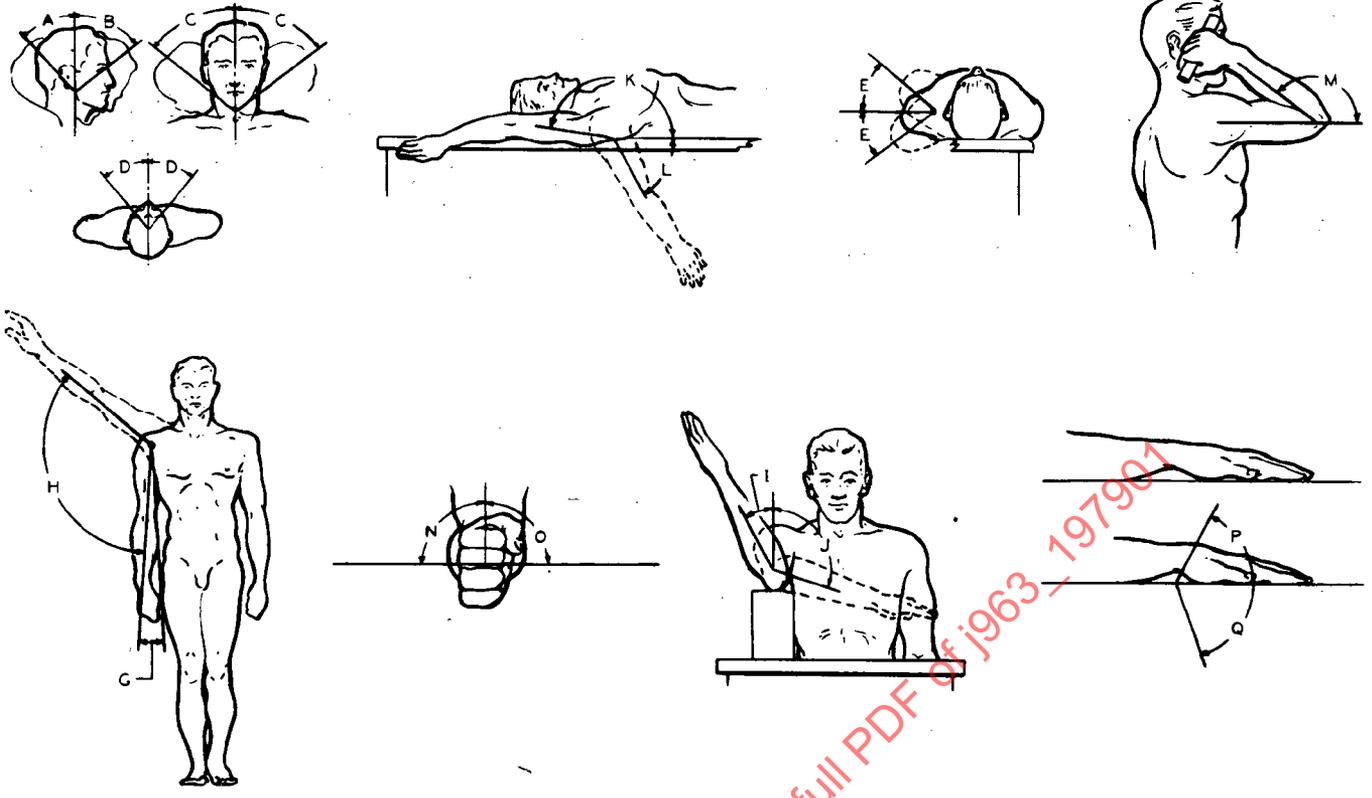


FIG. 2—RANGES OF MOTION (SEE TABLE 2).

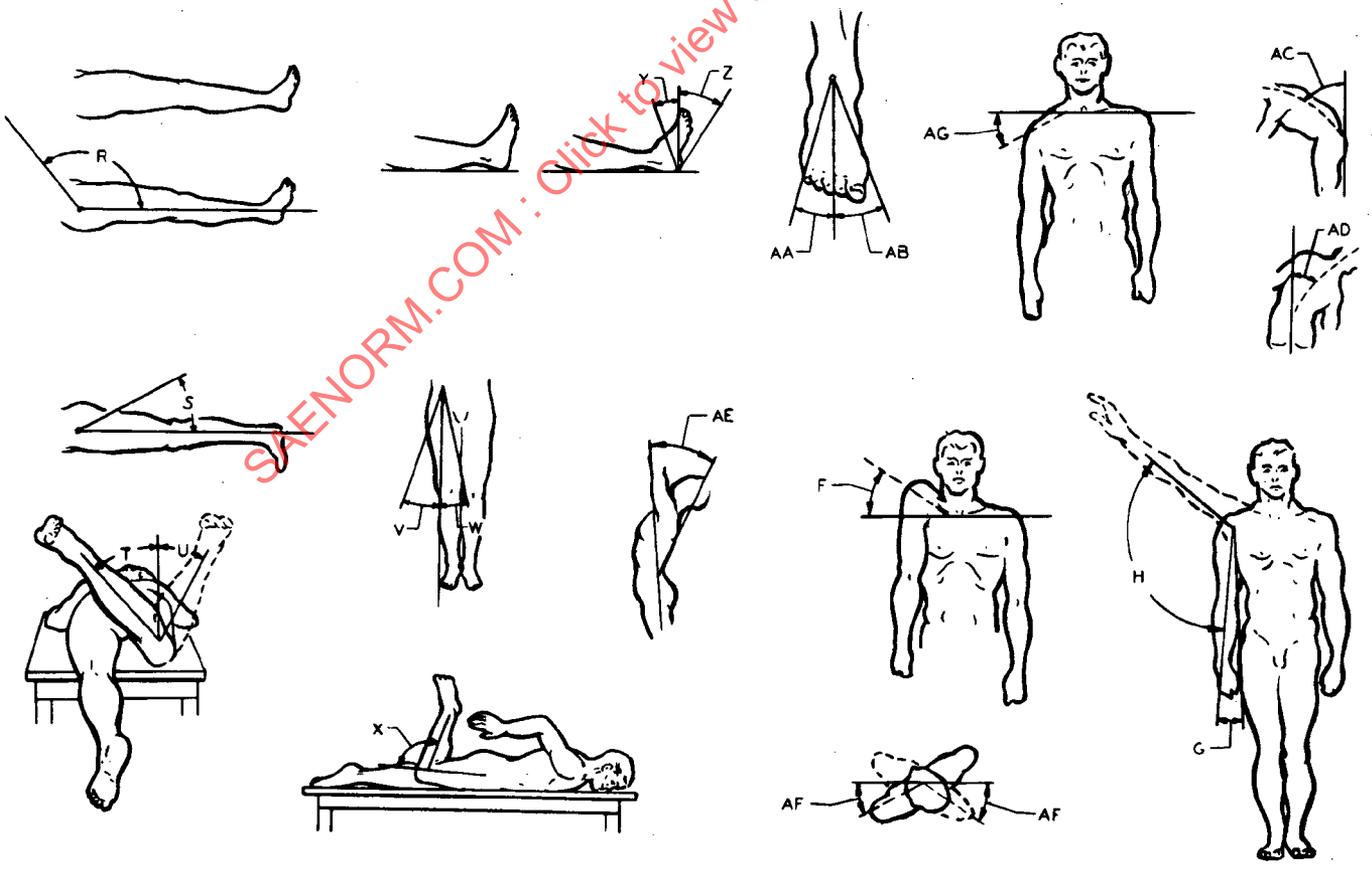


FIG. 3—RANGES OF MOTION (SEE TABLE 2)

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