



Fire Apparatus Manufacturer's Association

Firefighter Anthropometric Data White Paper

FAMA Technical Committee
Chassis Subcommittee

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Purpose

This paper has been created by the Chassis Technical Committee of the Fire Apparatus Manufacturer's Association for the follow purpose:

Provide guidance to fire apparatus designers on the range of firefighter sizes, weights, and shapes.

Establish minimum seat belt length data to be used in setting NFPA standards

Definition of Terms

Anthropometry The study of human body measurement for use in anthropological classification and comparison.

Description

In the spring of 2006, representatives of the International Association of Fire Chiefs (IAFC), the National Fallen Fire Fighters Foundation (NFFF) and the Fire Apparatus Manufacturers' Association (FAMA) met to discuss ways to improve the design of fire apparatus related to seating and seat belts. It was determined that the first order of business was to obtain better information concerning the size, shape, weight and reach of fire fighters wearing bunker gear. This information could then be used to better design vehicles and products to fit today's fire fighters.

The data in this study was gathered from 15 fire departments representing 9 states and one Canadian province. Detailed measurement instructions and photographs were provided to each participating department to encourage consistency in the results.

Each measurement set within the database was then reviewed to identify any obvious errors. The final cleaned database consists of 737 subject measurements of which 682 are male and 55 are female. The average subject age is 38, with a standard deviation of 9, a maximum of age of 68, and a minimum of age of 16.

Results are given for the combined population as well as male and female populations independently.

Height, Standing



		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Height, Standing, Barefoot (in)	Combined	65.3	70.0	74.5	70.0	2.8	70.0	60.0	79.8
Height, Standing, Barefoot (in)	Male	65.8	70.3	74.5	70.2	2.7	70.3	61.3	79.8
Height, Standing, Barefoot (in)	Female	62.3	66.3	70.1	66.5	2.4	66.3	60.0	71.0

		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Height, Standing, with Boots (in)	Combined	66.8	71.5	76.0	71.4	2.8	71.5	61.8	81.5
Height, Standing, with Boots (in)	Male	67.0	71.8	76.0	71.7	2.7	71.8	62.8	81.5
Height, Standing, with Boots (in)	Female	63.9	68.0	71.8	68.0	2.4	68.0	61.8	73.0

		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Height, Standing, with Boots and Helmet (in)	Combined	70.0	74.5	79.0	74.3	2.8	74.5	65.5	85.5
Height, Standing, with Boots and Helmet (in)	Male	70.3	74.6	79.0	74.6	2.7	74.6	65.5	85.5
Height, Standing, with Boots and Helmet (in)	Female	67.6	71.0	74.3	71.1	2.1	71.0	66.3	75.5

Height, Sitting

Sitting Height



(Dimension from hard sitting surface to top of head or helmet)

		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Sitting Height, Bare Head (in)	Combined	33.8	36.0	38.8	36.1	1.5	36.0	31.5	40.8
Sitting Height, Bare Head (in)	Male	34.0	36.3	38.8	36.3	1.4	36.3	31.8	40.8
Sitting Height, Bare Head (in)	Female	32.9	34.5	36.3	34.4	1.2	34.5	31.5	37.0

		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Sitting Height with Helmet (in)	Combined	36.5	39.0	42.0	39.2	1.6	39.0	34.3	44.8
Sitting Height with Helmet (in)	Male	37.0	39.3	42.0	39.3	1.6	39.3	34.8	44.8
Sitting Height with Helmet (in)	Female	35.6	37.5	39.6	37.5	1.3	37.5	34.3	40.8

Height, Sitting, Shoulder

Sitting Shoulder Height



(Dimension from hard sitting surface to top of shoulder)

		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Sitting Shoulder Height (in)	Combined	23.3	25.5	28.0	25.6	1.4	25.5	21.0	32.0
Sitting Shoulder Height (in)	Male	23.5	25.8	28.0	25.7	1.4	25.8	21.0	32.0
Sitting Shoulder Height (in)	Female	23.0	24.3	26.1	24.3	1.0	24.3	22.5	26.8

Height, Sitting, Knee

Seated Knee Height



		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Seated Knee Height (in)	Combined	22.0	23.8	25.5	23.7	1.1	23.8	20.5	28.5
Seated Knee Height (in)	Male	22.0	23.8	25.5	23.8	1.1	23.8	20.5	28.5
Seated Knee Height (in)	Female	21.3	23.0	24.3	22.8	1.0	23.0	20.5	24.8

Weight, Personnel

Weight



		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Weight In Street Clothes and Shoes (lb)	Combined	155	202	260	205	32	202	121	335
Weight In Street Clothes and Shoes (lb)	Male	165	205	263	208	31	205	140	335
Weight In Street Clothes and Shoes (lb)	Female	129	163	226	170	32	163	121	289

		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Suited Weight No SCBA (lb)	Combined	178	225	286	228	33	225	144	360
Suited Weight No SCBA (lb)	Male	186	227	287	230	31	227	162	360
Suited Weight No SCBA (lb)	Female	154	185	249	192	32	185	144	315

		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Suited Weight With SCBA (lb)	Combined	204	250	311	253	33	250	170	385
Suited Weight With SCBA (lb)	Male	212	253	312	256	31	253	185	385
Suited Weight With SCBA (lb)	Female	175	212	273	217	32	212	170	340

Weight, Equipment

Personal Protective Equipment Weight

Note: These percentile statistics are relative to the distribution of the equipment independent of the characteristics of the subject (i.e. of all equipment measured, the 5th percentile SCBA weighs 17 lb, this does not imply that all 5th percentile subjects wear 17 lb SCBAs).

		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Added Weight of Bunker Gear and Accessories (lb)	Combined	17	23	30	23	4	23	10	40
Added Weight of Bunker Gear and Accessories (lb)	Male	17	23	30	23	4	23	10	40
Added Weight of Bunker Gear and Accessories (lb)	Female	17	21	31	22	4	21	13	35

		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
SCBA Weight (lb)	Combined	17	27	30	26	4	27	13	47
SCBA Weight (lb)	Male	17	27	30	26	4	27	13	47
SCBA Weight (lb)	Female	17	27	30	25	4	27	17	30

		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Total Added Weight with SCBA (lb)	Combined	37	49	56	49	6	49	31	68
Total Added Weight with SCBA (lb)	Male	37	49	56	49	6	49	31	68
Total Added Weight with SCBA (lb)	Female	36	48	55	48	6	48	34	65

Shoulder

Shoulder



		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Shoulder Circumference (in)	Combined	51.4	57.0	64.0	57.4	3.8	57.0	42.0	73.5
Shoulder Circumference (in)	Male	52.5	57.5	64.0	57.7	3.5	57.5	45.0	73.5
Shoulder Circumference (in)	Female	45.9	53.5	60.7	53.4	4.3	53.5	42.0	63.5

		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Shoulder Width (in)	Combined	18.2	20.5	23.3	20.6	1.5	20.5	16.3	26.0
Shoulder Width (in)	Male	18.5	20.8	23.3	20.8	1.4	20.8	17.3	26.0
Shoulder Width (in)	Female	17.0	18.5	21.8	18.9	1.5	18.5	16.3	23.0

Stomach

Stomach



		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Stomach Circumference (in)	Combined	41.9	49.0	56.0	48.6	4.4	49.0	34.5	66.0
Stomach Circumference (in)	Male	42.0	49.0	56.0	48.9	4.3	49.0	36.0	66.0
Stomach Circumference (in)	Female	38.0	46.0	52.1	45.2	4.9	46.0	34.5	57.0

		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Stomach Depth (in)	Combined	10.5	13.3	16.0	13.3	1.7	13.3	6.3	19.5
Stomach Depth (in)	Male	10.8	13.3	16.0	13.4	1.7	13.3	6.3	19.5
Stomach Depth (in)	Female	10.0	12.8	15.3	12.5	1.7	12.8	8.0	16.3

Torso

Width Across Torso



		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Width Across Torso (in)	Combined	12.5	14.8	17.8	14.9	1.7	14.8	11.3	29.0
Width Across Torso (in)	Male	12.5	15.0	18.0	15.0	1.7	15.0	11.5	29.0
Width Across Torso (in)	Female	11.8	14.0	16.0	13.9	1.4	14.0	11.3	17.0

Arms

Width Across Arms



		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Width Across Arms (in)	Combined	21.3	24.0	27.3	24.1	1.9	24.0	18.0	33.0
Width Across Arms (in)	Male	21.3	24.0	27.5	24.2	1.9	24.0	18.0	33.0
Width Across Arms (in)	Female	21.0	23.0	25.6	23.1	1.6	23.0	19.8	26.8

Hips

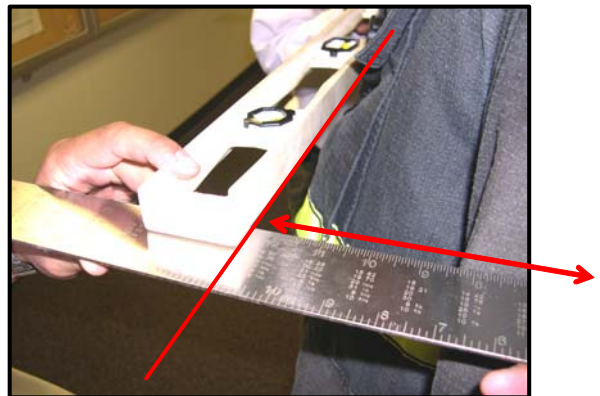
Width Across Hips



		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Width Across Hips (in)	Combined	14.2	16.3	19.8	16.6	1.7	16.3	12.3	24.0
Width Across Hips (in)	Male	14.3	16.3	19.5	16.6	1.7	16.3	12.3	24.0
Width Across Hips (in)	Female	13.5	16.3	19.8	16.6	1.8	16.3	13.0	20.0

Chest

Chest Depth



		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Chest Depth (in)	Combined	10.5	12.3	15.0	12.5	1.5	12.3	8.8	21.5
Chest Depth (in)	Male	10.5	12.5	15.0	12.5	1.4	12.5	8.8	21.5
Chest Depth (in)	Female	10.0	11.5	14.3	11.8	1.3	11.5	9.0	15.8

Hand Reach, Rearward, Upper

Rearward Upper Hand Reach



(Dimension is the distance from a flat seat-back that the subject can reach)

		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Rearward Upper Hand Reach - No Torso Twist (in)	Combined	5.0	9.5	13.5	9.5	2.5	9.5	3.0	16.0
Rearward Upper Hand Reach - No Torso Twist (in)	Male	5.0	9.5	13.5	9.5	2.5	9.5	3.0	16.0
Rearward Upper Hand Reach - No Torso Twist (in)	Female	5.9	9.8	14.2	9.8	2.5	9.8	4.0	15.0

(Dimension is the distance from a flat seat-back that the subject can reach while rotating his upper body, but not his buttocks. Negative value indicates the subject could reach beyond the seat-back)

		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Rearward Upper Hand Reach - With Torso Twist (in)	Combined	2.0	6.0	10.0	5.9	2.4	6.0	-4.0	13.5
Rearward Upper Hand Reach - With Torso Twist (in)	Male	2.0	6.0	10.0	5.9	2.4	6.0	-4.0	13.5
Rearward Upper Hand Reach - With Torso Twist (in)	Female	1.7	6.0	10.3	6.1	2.6	6.0	1.0	11.5

Hand Reach, Rearward, Lower

Rearward Lower Hand Reach



(Dimension is the distance from a flat seat-back that the subject can reach)

		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Rearward Lower Hand Reach - No Torso Twist (in)	Combined	5.5	11.5	16.0	11.4	3.1	11.5	2.5	21.0
Rearward Lower Hand Reach - No Torso Twist (in)	Male	5.8	11.5	16.0	11.4	3.1	11.5	2.5	21.0
Rearward Lower Hand Reach - No Torso Twist (in)	Female	5.4	10.5	15.7	10.7	3.0	10.5	4.0	17.0

(Dimension is the distance from a flat seat-back that the subject can reach while rotating his upper body, but not his buttocks. Negative value indicates the subject could reach beyond the seat-back)

		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Rearward Lower Hand Reach - With Torso Twist (in)	Combined	2.0	6.5	12.0	6.8	3.1	6.5	-5.0	17.5
Rearward Lower Hand Reach - With Torso Twist (in)	Male	2.3	6.5	12.0	6.8	3.1	6.5	-5.0	17.5
Rearward Lower Hand Reach - With Torso Twist (in)	Female	1.4	7.0	11.0	6.7	3.1	7.0	1.0	12.5

Hand Reach, Side Upper

Side Hand Upper Reach



(Dimension is the distance from the center of the head to the center of the grip)

		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Side Hand Upper Reach - No Torso Twist (in)	Combined	7.5	11.0	14.5	11.1	2.2	11.0	1.0	22.0
Side Hand Upper Reach - No Torso Twist (in)	Male	7.5	11.0	14.5	11.1	2.2	11.0	1.0	22.0
Side Hand Upper Reach - No Torso Twist (in)	Female	8.0	11.0	15.2	11.0	2.5	11.0	1.0	16.0

(Dimension is the distance from the center of the head to the center of the grip while rotating his upper body, but not his buttocks.)

		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Side Hand Upper Reach - With Torso Twist (in)	Combined	11.5	16.0	20.5	15.9	2.8	16.0	5.3	27.0
Side Hand Upper Reach - With Torso Twist (in)	Male	11.5	16.0	20.5	15.9	2.8	16.0	5.3	27.0
Side Hand Upper Reach - With Torso Twist (in)	Female	11.7	15.0	19.8	15.3	2.6	15.0	10.0	21.5

Hand Reach, Side, Lower

Side Hand Lower Reach



(Dimension is the distance from the center of the body to the center of the grip without twisting the torso)

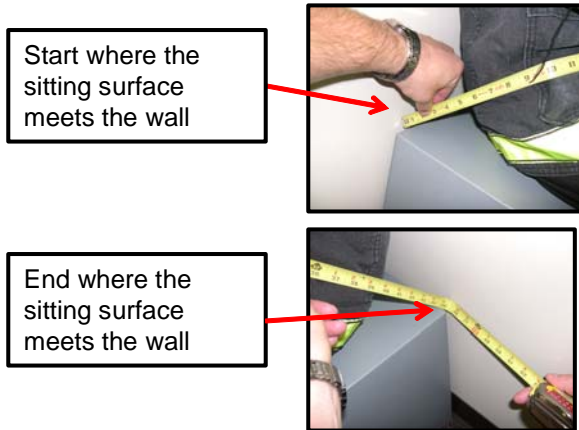
		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Side Hand Lower Reach - No Torso Twist (in)	Combined	7.0	11.0	14.8	10.8	2.4	11.0	3.0	18.0
Side Hand Lower Reach - No Torso Twist (in)	Male	6.5	11.0	14.8	10.9	2.4	11.0	3.0	18.0
Side Hand Lower Reach - No Torso Twist (in)	Female	7.0	10.5	14.2	10.5	2.3	10.5	7.0	17.0

(Dimension is the distance from the center of the body to the center of the grip with subject reaching as far to the side as possible level with his hips while rotating his upper body, but not his buttocks)

		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Side Hand Lower Reach - With Torso Twist (in)	Combined	9.5	16.0	20.0	15.2	3.2	16.0	6.5	30.0
Side Hand Lower Reach - With Torso Twist (in)	Male	9.5	16.0	20.0	15.3	3.2	16.0	6.5	30.0
Side Hand Lower Reach - With Torso Twist (in)	Female	10.0	14.5	21.0	14.5	3.0	14.5	9.5	22.0

Seat Belt, Lap

Lap Belt Length



		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Lap Belt Length (in)	Combined	35.0	43.0	50.0	42.8	4.5	43.0	27.0	57.0
Lap Belt Length (in)	Male	36.0	43.0	50.0	43.1	4.3	43.0	27.0	57.0
Lap Belt Length (in)	Female	29.4	39.0	47.7	38.7	5.2	39.0	27.5	50.3

Seat Belt, Shoulder

Shoulder Belt Length



		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Shoulder Belt Length (in)	Combined	34.0	44.0	49.0	43.1	4.4	44.0	28.0	56.5
Shoulder Belt Length (in)	Male	35.5	44.0	49.2	43.4	4.1	44.0	28.0	56.5
Shoulder Belt Length (in)	Female	29.7	41.0	47.0	39.2	5.4	41.0	29.0	50.0

Combined Lap and Shoulder Belt

Use of this data must consider that an actual seat and belt installation has many more variables than those measured in this study. The lap and shoulder measurements given can be applied to actual seat belts only after accounting for variables such as:

- Adjustable D-Loop Mounting
- Belt Anchor Location
- Buckle Stalk Length
- Seat Adjustment
 - Fore-Aft
 - Recline Angle
 - Up-Down

Combined lap and shoulder belt measurements:

		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
3-Point Belt Length Total (in)	Combined	70.5	86.5	98.5	85.9	8.3	86.5	56.5	111.0
3-Point Belt Length Total (in)	Male	72.5	87.0	98.5	86.6	7.8	87.0	61.0	111.0
3-Point Belt Length Total (in)	Female	60.8	79.5	91.9	77.9	10.1	79.5	56.5	100.3

Compare these values to actual seat belt installations as follows:

3-Point Belt Total Length

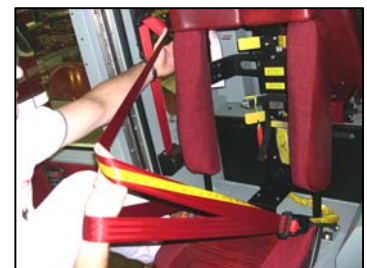
Lap Belt Portion



- Keep the extended belt in the exact position it was when measuring the shoulder belt length.
- Position the beginning of the tape on the lap belt portion to simulate the lap belt measurement.
- Record the length from one side to the other at the intersection of the sitting surface and the back rest.

3-Point Belt Total Length

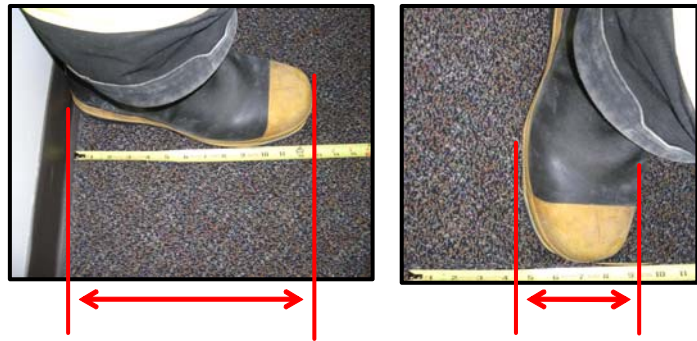
Shoulder Belt Portion



- Pull the belt webbing out until no more length is left in the retractor
- Position the beginning of the tape on the shoulder belt portion to simulate the shoulder belt measurement.
- Record the length at the intersection of the sitting surface and the back rest.

Boots

Boot Size



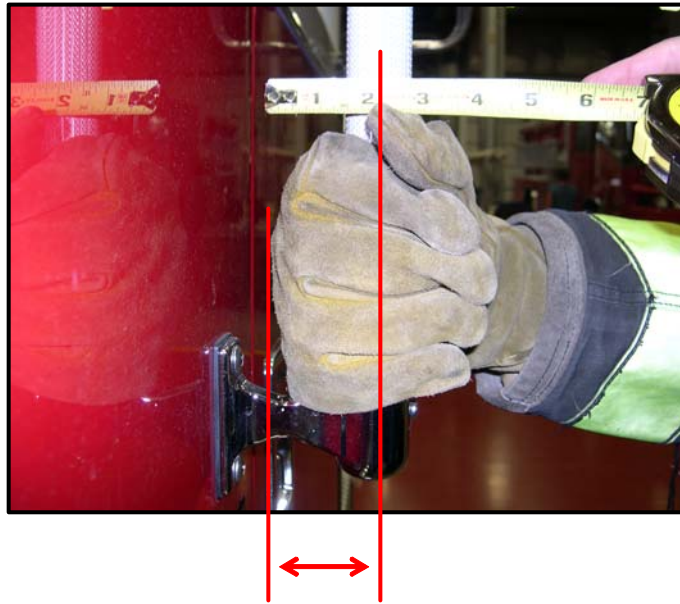
		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Boot Length (in)	Combined	11.5	12.5	13.5	12.4	0.7	12.5	10.0	15.0
Boot Length (in)	Male	11.5	12.5	13.5	12.5	0.7	12.5	10.0	15.0
Boot Length (in)	Female	10.5	11.5	12.1	11.5	0.6	11.5	10.0	13.0

		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Boot Width (in)	Combined	4.0	4.8	5.0	4.7	0.3	4.8	3.5	6.0
Boot Width (in)	Male	4.0	4.8	5.0	4.7	0.3	4.8	3.8	6.0
Boot Width (in)	Female	4.0	4.8	4.8	4.6	0.3	4.8	3.5	5.0

Hand Clearance

Hand Clearance

(Dimension from the center of a one-inch bar to the outside of a gloved hand.)



		5th Percentile	50th Percentile	95th Percentile	Average	Standard Deviation	Median	Minimum	Maximum
Hand Clearance (in)	Combined	2.0	2.5	3.0	2.5	0.4	2.5	1.0	5.0
Hand Clearance (in)	Male	2.0	2.5	3.0	2.5	0.4	2.5	1.5	5.0
Hand Clearance (in)	Female	1.5	2.3	2.8	2.1	0.6	2.3	1.0	4.5

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