

B11 Ergonomics

Table D.1 – Maximum acceptable weight of lift for males (pounds–force\*)  
2–hand symmetrical lift

a) H O R I Z O N T A L	b) V E R T I C A L	c) P E R C E N T	Floor level to knuckle height									Knuckle height to shoulder height									Shoulder height to arm reach								
			One lift every									One lift every									One lift every								
			5	9	14	1	2	5	30	8	5	9	14	1	2	5	30	8	5	9	14	1	2	5	30	8			
			sec	min						hr	sec	min						hr	sec	min						hr			
30	90	75	13	15	20	24	29	31	31	37	18	22	26	29	31	31	35	37	13	18	20	22	22	24	26	29			
			20	24	29	35	42	44	46	53	22	31	35	40	40	42	46	51	18	22	26	31	31	31	35	37			
			50	26	33	37	48	55	59	62	70	29	37	44	48	51	53	57	64	22	29	33	37	37	40	44	48		
	20	75	50	13	18	20	26	29	33	33	37	18	24	29	33	33	35	40	42	13	18	20	26	26	26	31	33		
				20	24	29	37	42	46	48	55	24	33	37	44	44	46	51	55	18	24	26	33	33	35	40	44		
				50	29	33	40	51	57	62	64	75	31	42	46	55	55	57	64	70	22	31	35	42	44	44	51	55	
	10	75	50	18	20	24	29	33	35	37	44	22	29	33	40	40	42	46	51	18	22	24	31	31	31	35	40		
				24	29	33	42	48	53	53	62	29	37	44	46	53	55	59	66	22	29	33	40	40	42	46	51		
				50	33	40	46	57	64	70	73	84	37	48	55	60	66	68	77	84	26	35	42	51	51	53	59	64	
20	90	75	15	18	22	29	33	35	37	44	18	22	26	29	31	31	35	37	15	20	22	26	26	29	31	35			
			22	26	31	42	48	53	53	62	22	31	35	40	40	42	46	51	20	24	26	35	35	37	42	46			
			50	31	35	42	57	64	70	73	84	29	37	44	48	51	53	57	64	24	33	37	44	46	46	53	57		
	20	75	50	15	20	22	31	33	35	40	44	18	24	29	33	33	35	40	42	15	20	24	31	31	31	35	40		
				22	29	31	44	51	55	55	66	24	33	37	44	44	46	51	55	20	26	31	40	40	42	46	51		
				50	31	37	44	59	68	73	75	88	31	42	46	55	55	57	64	70	26	33	40	51	51	53	59	64	
	10	75	50	18	22	26	35	40	42	44	51	22	29	33	40	40	42	46	51	20	24	26	35	35	37	42	46		
				26	33	37	51	57	62	64	73	29	37	44	51	53	55	59	66	24	31	35	46	46	48	55	59		
				50	35	44	51	66	75	81	84	99	37	48	55	66	66	68	77	84	31	40	46	59	59	62	70	77	
10	90	75	18	22	24	33	37	42	42	51	18	24	29	33	33	35	40	42	18	22	26	31	31	33	35	40			
			26	31	33	48	55	62	62	73	24	33	37	44	44	46	51	55	22	31	35	40	42	42	48	53			
			50	35	42	48	66	75	81	84	97	31	42	46	55	55	57	64	70	29	37	44	51	53	55	59	66		
	20	75	50	20	22	26	35	40	44	44	53	20	26	31	37	37	40	44	48	18	24	29	35	35	37	40	44		
				26	33	40	51	57	62	64	75	36	35	40	48	51	51	57	64	24	31	37	46	46	48	53	57		
				50	37	44	53	68	77	84	86	101	33	44	51	62	64	66	73	79	31	40	46	57	59	62	68	75	
	10	75	50	22	26	31	40	44	48	51	59	24	31	35	44	44	46	51	57	22	29	33	42	42	42	48	53		
				33	40	49	57	66	70	73	84	31	40	46	57	59	62	68	75	29	37	44	53	55	57	64	68		
				50	44	53	62	77	88	95	97	114	40	51	59	73	75	77	86	95	35	48	53	68	68	73	79	88	

NOTES:

- a) Horizontal distance measured from chest (or forward foot) to hand grasp (inches)
- b) Vertical distance of lift (inches)
- c) Percent of industrial population capable of performing lift without excessive stress
- \*) Rounded from original metric study

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**Table D.2 – Maximum acceptable weight of lift for females (pounds force •)  
2-hand symmetrical lift**

a) H O R I Z O N T A L	b) V E R T I C A L	c) P E R C E N T	Floor level to knuckle height									Knuckle height to shoulder height									Shoulder height to arm reach								
			One lift every									One lift every									One lift every								
			5	9	14	1	2	5	30	8	5	9	14	1	2	5	30	8	5	9	14	1	2	5	30	8			
			sec			min			hr			sec			min			hr			sec			min			hr		
30	90	11	13	15	15	18	18	20	26	11	13	15	20	20	20	22	26	9	11	11	13	15	15	15	18				
			75	15	18	20	20	22	22	24	31	13	15	18	22	24	24	26	31	11	13	13	15	18	18	18	22		
			50	18	22	22	24	26	26	29	37	13	18	20	24	26	26	29	35	13	15	15	18	20	20	22	24		
	20	13	15	18	18	20	20	22	31	13	15	18	20	22	22	24	29	11	13	15	15	15	15	18	20				
				75	15	20	20	22	24	24	26	37	15	18	20	24	26	26	26	33	13	15	18	18	20	20	20	24	
				50	20	22	24	26	29	31	33	46	20	20	24	29	31	31	33	37	15	18	20	20	22	22	24	29	
	10	13	18	18	20	20	20	24	31	13	15	18	22	24	24	26	31	11	13	15	18	18	18	20	22				
				75	18	22	24	24	26	26	29	40	15	18	20	26	29	29	31	37	13	15	18	20	20	20	22	26	
				50	22	26	29	29	31	31	35	46	20	22	24	31	33	33	35	42	15	18	20	22	24	24	26	31	
20	90	11	13	15	18	18	18	20	29	11	13	15	20	20	20	22	26	9	11	11	15	15	15	18	20				
			75	15	18	20	22	22	22	26	35	13	15	18	22	24	24	26	31	11	13	13	18	18	18	20	24		
			50	18	22	22	26	26	29	31	42	15	18	20	24	26	26	29	35	13	15	15	20	22	22	24	26		
	20	13	15	18	20	22	22	24	33	13	15	18	20	22	22	24	29	11	13	15	15	18	18	20	22				
				75	15	15	20	24	26	26	31	40	15	18	20	24	26	26	29	33	13	15	18	20	20	20	22	26	
				50	20	22	24	29	33	33	35	48	20	20	24	29	31	31	33	37	15	18	20	22	24	24	26	31	
	10	13	18	20	20	22	22	24	33	13	15	18	22	24	24	26	31	11	13	15	18	20	20	22	26				
				75	18	22	24	26	26	29	31	42	15	18	20	26	29	29	31	37	13	15	18	20	22	22	24	29	
				50	22	26	29	31	33	33	37	51	20	22	24	31	33	33	35	42	15	18	20	24	26	26	29	33	
10	90	15	18	20	20	22	22	24	33	13	15	18	20	22	22	24	29	11	13	15	18	20	20	22	24				
			75	18	22	24	26	29	29	31	42	15	18	20	24	26	26	29	33	13	15	18	20	22	22	24	29		
			50	22	26	29	31	33	35	37	51	20	20	24	29	31	31	33	37	15	18	20	24	26	26	29	33		
	20	15	20	20	24	26	26	29	40	18	18	20	22	24	24	26	31	15	15	18	20	22	22	24	26				
				75	20	24	26	31	33	33	35	48	20	22	24	26	29	29	31	37	18	18	20	24	24	24	26	31	
				50	24	29	31	35	40	40	44	59	22	24	29	31	33	33	37	42	20	22	24	26	29	29	31	37	
	10	18	22	24	24	26	26	31	42	18	18	20	26	26	26	31	35	15	15	18	22	24	24	26	31				
				75	22	26	29	31	33	33	37	51	20	22	24	29	31	31	35	40	18	18	20	26	26	26	31	35	
				50	26	33	35	37	40	42	46	62	22	24	26	35	37	37	40	46	20	22	24	29	31	31	35	40	

**NOTES:**

- a) Horizontal distance measured from chest (or forward foot) to hand grasp (inches)
- b) Vertical distance of lift (inches)
- c) Percent of industrial population capable of performing lift without excessive stress
- \*) Rounded from original metric study

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Table D.3 – Maximum acceptable weight of lower for males (pounds force \*)

a) H O R I Z O N T A L	b) V E R T I C A L	c) P E R C E N T	Floor level to knuckle height								Knuckle height to shoulder height								Shoulder height to arm reach								
			One lower every								One lower every								One lower every								
			5	9	14	1	2	5	30	8	5	9	14	1	2	5	30	8	5	9	14	1	2	5	30	8	
			sec			min					hr	sec			min					hr	sec			min			
30	90	75	50	15	20	22	26	31	33	35	44	22	24	31	31	33	33	35	42	13	15	20	20	22	22	24	29
				22	29	31	40	44	48	48	64	29	35	40	40	46	46	46	57	20	22	26	26	31	31	31	40
				31	37	42	51	59	64	66	84	40	44	53	53	59	59	62	75	24	29	33	35	38	38	42	51
	20	75	50	16	22	24	29	33	35	37	46	24	26	31	33	37	37	40	48	15	18	20	22	26	26	26	33
				24	31	33	40	46	51	51	66	31	37	44	46	53	53	53	66	20	24	29	31	35	35	35	44
				31	40	44	53	62	66	68	88	42	46	55	59	68	68	68	84	26	31	35	40	46	46	46	57
	10	75	50	20	24	26	33	37	40	42	53	26	31	37	40	46	46	46	57	18	20	24	26	31	31	31	37
				29	35	37	46	53	55	57	75	37	44	51	55	62	62	62	77	24	29	33	35	42	42	42	53
				37	46	51	59	68	75	77	99	48	55	66	70	79	79	81	99	31	35	42	46	53	53	55	68
20	90	75	50	18	22	24	33	37	40	42	53	22	24	31	31	33	33	35	42	15	18	22	24	26	26	26	33
				26	33	35	46	53	57	57	75	29	35	40	40	46	46	46	57	22	24	31	33	37	37	37	46
				33	42	46	59	68	75	77	99	40	44	53	53	59	59	62	75	29	33	37	42	48	48	48	59
	20	75	50	20	24	26	33	37	42	42	55	24	26	31	33	37	37	40	48	18	20	22	26	31	31	31	37
				26	33	37	48	55	57	62	77	31	37	44	46	53	53	53	66	22	26	31	35	42	42	42	53
				35	44	48	64	73	77	81	103	42	46	55	59	68	68	68	84	31	35	40	46	53	53	55	68
	10	75	50	22	29	31	37	44	46	48	62	26	31	37	40	46	46	46	57	20	22	26	31	35	35	35	44
				31	40	42	53	62	66	68	88	33	44	51	53	62	62	62	77	26	31	37	42	48	48	48	62
				42	53	57	70	81	88	90	119	48	55	66	70	79	79	81	99	35	40	48	55	64	64	64	79
10	90	75	50	22	26	29	37	42	46	46	53	24	26	31	33	37	37	40	48	20	22	26	26	31	31	31	40
				31	37	42	53	59	64	66	86	31	37	44	46	53	53	53	66	26	29	35	37	42	42	42	53
				40	51	55	70	79	86	88	112	42	46	55	59	68	68	68	84	33	37	46	48	55	55	55	68
	20	75	50	22	29	31	37	44	48	48	64	24	29	33	37	44	44	44	52	20	22	26	31	35	35	35	66
				31	40	44	52	62	66	70	88	33	40	46	51	59	59	59	73	26	31	37	42	48	48	48	59
				42	53	57	73	81	88	92	117	44	51	59	66	77	77	77	95	35	42	48	53	62	62	62	77
	10	75	50	26	33	35	44	51	53	55	70	29	33	40	44	51	51	51	64	24	26	33	35	42	42	42	51
				37	46	51	62	70	75	79	101	40	46	55	59	68	68	70	86	33	37	44	48	57	57	57	70
				51	62	68	81	92	101	103	132	51	59	70	77	90	90	90	112	42	48	57	64	73	73	73	90

NOTES:

- a) Horizontal distance measured from chest (or forward foot) to hand grasp (inches)
- b) Vertical distance of lower (inches)
- c) Percent of industrial population capable of performing lower without excessive stress
- \*) Rounded from original metric study

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Table D.4 – Maximum acceptable weight of lower for females (pounds force \*)

a) H O R I Z O N T A L	b) V E R T I C A L	c) P E R C E N T	Floor level to knuckle height									Knuckle height to shoulder height									Shoulder height to arm reach								
			One lower every									One lower every									One lower every								
			5	9	14	1	2	5	30	8	5	9	14	1	2	5	30	8	5	9	14	1	2	5	30	8			
			sec			min			hr			sec			min			hr			sec			min			hr		
30	90	30	90	11	13	15	15	18	18	20	26	13	13	15	18	20	22	22	29	11	11	11	13	15	15	15	20		
			75	13	18	18	20	22	22	24	31	15	18	18	22	24	26	26	33	11	13	13	15	18	20	20	24		
			50	15	20	22	24	26	26	29	37	18	20	22	26	29	31	31	40	15	18	18	18	22	22	22	29		
	20	75	50	90	13	15	15	18	20	22	22	31	15	18	18	20	22	24	24	31	11	13	13	13	15	18	18	22	
				75	15	18	20	22	24	26	29	37	18	20	20	24	26	29	29	37	15	15	17	17	20	22	22	26	
				50	18	22	24	26	31	31	33	44	22	24	24	29	33	35	35	44	18	20	20	20	24	26	26	33	
	10	75	50	90	13	18	18	20	22	22	24	31	15	18	18	22	24	26	26	33	11	13	13	15	18	18	20	24	
				75	18	22	22	24	26	26	29	37	18	20	20	26	29	33	33	42	15	15	18	20	22	24	24	29	
				50	20	24	26	29	31	33	35	46	22	24	24	31	35	40	40	48	18	20	20	22	26	29	29	35	
20	90	30	90	11	13	15	18	18	20	22	29	13	13	15	18	20	22	22	29	11	11	11	13	15	18	18	22		
			75	13	18	18	20	22	24	26	35	15	18	18	22	24	24	26	33	11	13	13	18	20	20	20	24		
			50	18	20	22	24	29	29	31	42	18	20	22	26	29	31	31	40	15	18	18	20	22	24	24	31		
	20	75	50	90	13	15	15	20	22	22	24	33	15	18	18	20	22	24	24	31	11	13	13	18	20	20	20	24	
				75	15	18	20	24	26	29	31	40	18	20	22	24	26	29	29	37	15	15	18	18	22	22	22	29	
				50	18	22	24	29	33	33	35	48	22	24	24	29	33	35	35	44	18	20	20	22	24	29	29	35	
	10	75	50	90	13	18	18	20	22	24	26	33	15	18	18	20	22	24	26	33	11	13	13	18	20	20	20	26	
				75	18	22	22	24	29	29	31	42	18	20	22	26	29	33	33	42	15	15	18	20	22	26	26	31	
				50	20	24	26	31	33	35	37	51	22	24	24	31	35	40	40	48	18	20	20	24	29	31	31	37	
10	90	30	90	13	18	20	20	22	24	26	33	15	18	18	20	22	24	24	31	13	13	15	18	20	20	20	26		
			75	18	22	24	24	29	29	31	42	18	20	20	24	26	29	29	37	15	15	18	20	22	24	24	31		
			50	22	26	29	31	33	35	37	51	22	24	24	29	33	35	35	44	18	20	22	24	29	31	31	37		
	20	75	50	90	15	20	20	24	26	29	31	40	18	20	20	22	24	26	26	33	15	18	18	18	22	24	24	29	
				75	20	24	24	29	33	35	37	48	20	24	24	26	31	33	33	42	18	20	22	22	26	29	29	35	
				50	22	29	31	35	40	42	44	59	24	29	29	31	35	40	40	48	22	24	24	26	31	33	33	42	
	10	75	50	90	18	22	22	24	29	29	31	42	18	20	20	24	26	29	29	37	15	18	18	20	24	26	26	33	
				75	22	26	29	31	33	35	37	51	20	24	24	29	33	35	35	46	18	20	22	24	29	31	31	40	
				50	26	31	33	37	42	44	46	62	24	29	29	35	40	44	44	55	22	24	24	31	33	37	37	46	

NOTES:

- a) Horizontal distance measured from chest (or forward foot) to hand grasp (inches)
- b) Vertical distance of lower (inches)
- c) Percent of industrial population capable of performing lower without excessive stress
- \*) Rounded from original metric study

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**Table D.5 – Maximum acceptable forces of push for males (pounds–force\*)**

		One push every						One push every						One push every								
		5	14	1	2	5	30	8	5	14	1	2	5	30	8	5	14	1	2	5	30	8
		sec		min				hr	sec		min				hr	sec		min				hr
<b>INITIAL FORCES (c)</b>																						
		7 foot push						25 foot push						50 foot push								
(a)	90	44	48	55	55	57	57	68	31	35	46	46	48	48	57	35	40	42	42	44	46	55
	75	57	64	70	70	75	75	90	40	44	59	59	62	62	75	46	51	55	55	57	59	70
	50	70	79	88	88	92	92	112	51	55	73	73	77	77	92	57	64	68	68	73	73	88
(b)	90	46	53	57	57	62	62	75	35	40	51	51	55	55	66	40	46	48	48	51	53	62
	75	62	68	75	75	79	79	97	46	51	66	66	70	70	86	53	59	62	62	66	66	79
	50	75	84	95	95	99	99	119	57	64	84	84	88	88	106	64	73	77	77	81	84	99
(c)	90	42	48	53	53	55	57	68	29	31	44	44	46	46	57	33	37	42	42	44	44	53
	75	55	62	68	68	73	73	88	35	42	57	57	59	62	73	42	46	53	53	57	57	68
	50	68	77	86	86	90	90	110	44	51	70	70	75	77	90	51	59	66	66	70	73	86
<b>SUSTAINED FORCES (d)</b>																						
		7 foot push						25 foot push						50 foot push								
(a)	90	22	29	33	35	40	40	48	18	20	29	29	33	35	40	18	20	24	26	29	31	35
	75	29	37	46	48	53	55	66	22	29	37	40	44	46	55	24	29	33	35	40	40	48
	50	37	48	59	62	68	70	84	29	35	48	51	57	59	70	31	37	44	44	51	53	62
(b)	90	22	29	35	37	42	42	51	18	22	29	29	33	33	40	18	22	24	26	29	29	35
	75	31	40	48	48	55	57	68	24	29	37	40	44	46	55	24	29	33	35	40	40	46
	50	40	51	62	64	73	75	88	31	37	48	51	57	59	70	31	37	42	44	51	51	62
(c)	90	22	29	35	37	40	42	51	18	22	26	29	31	33	40	18	22	24	24	26	29	33
	75	31	40	46	48	55	57	68	24	29	37	37	42	44	53	24	29	31	33	37	37	46
	50	40	51	62	64	70	73	86	31	37	46	48	55	57	68	31	37	42	42	48	48	59
<b>INITIAL FORCES (c)</b>																						
		100 foot push						150 foot push						200 foot push								
(a)	90	-	-	33	35	42	42	53	-	-	29	31	35	35	44	-	-	-	26	31	31	40
	75	-	-	42	46	55	55	68	-	-	35	40	46	46	57	-	-	-	35	40	40	51
	50	-	-	53	59	68	68	84	-	-	44	51	57	57	73	-	-	-	44	48	48	62
(b)	90	-	-	37	42	48	48	59	-	-	31	35	42	42	51	-	-	-	31	35	35	44
	75	-	-	46	53	62	62	77	-	-	40	46	53	53	66	-	-	-	40	44	46	57
	50	-	-	59	66	77	77	97	-	-	51	57	66	66	81	-	-	-	48	57	57	70
(c)	90	-	-	31	35	42	42	51	-	-	26	31	35	35	44	-	-	-	26	31	31	37
	75	-	-	40	46	53	53	66	-	-	35	40	46	46	57	-	-	-	33	40	40	48
	50	-	-	51	57	66	66	81	-	-	44	48	57	57	70	-	-	-	42	48	48	52
<b>SUSTAINED FORCES (d)</b>																						
		100 foot push						150 foot push						200 foot push								
(a)	90	-	-	18	22	26	29	35	-	-	15	18	22	24	29	-	-	-	15	18	20	24
	75	-	-	24	29	35	40	46	-	-	22	24	29	33	40	-	-	-	20	24	29	33
	50	-	-	33	37	44	51	62	-	-	26	31	37	42	51	-	-	-	26	31	35	42
(b)	90	-	-	18	22	26	29	35	-	-	15	18	20	24	29	-	-	-	15	18	20	24
	75	-	-	24	29	35	40	46	-	-	20	24	29	33	40	-	-	-	20	24	26	33
	50	-	-	33	37	44	51	59	-	-	26	31	37	42	51	-	-	-	26	31	35	42
(c)	90	-	-	18	20	24	29	33	-	-	15	18	20	24	29	-	-	-	15	18	20	22
	75	-	-	24	29	33	37	44	-	-	20	24	26	31	37	-	-	-	20	22	26	31
	50	-	-	31	35	42	48	57	-	-	26	31	35	40	48	-	-	-	26	31	33	40

**NOTES:**

- a) Vertical distance from floor to hands (inches)
- b) Percent of industrial population capable of performing push without excessive stress
- c) The force required to start an object into motion
- d) The force required to keep an object in motion
- \*) Rounded from original metric study

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**Table D.6 – Maximum acceptable forces of push for females (pounds–force\*)**

		One push every						One push every						One push every										
		6	12	1	2	5	30	8	15	22	1	2	5	30	8	25	35	1	2	5	30	8		
		sec		min				hr	sec		min				hr	sec		min				hr		
<b>INITIAL FORCES (c)</b>																								
		7 foot push						25 foot push						50 foot push										
(a)	(b)	90	31	33	37	40	44	46	48	33	35	35	35	40	42	44	26	31	31	31	33	35	37	
		53	75	37	40	46	48	53	55	59	40	42	42	44	48	51	53	33	37	37	37	42	44	46
		50	44	48	55	57	64	66	70	46	51	51	53	57	59	64	40	44	44	44	48	51	55	
		90	31	33	37	40	44	46	48	31	33	35	37	42	42	46	24	29	31	31	35	35	37	
		35	75	37	40	46	48	53	55	59	37	40	44	44	48	51	55	31	35	37	37	42	44	46
		50	44	48	55	57	64	66	70	44	48	51	53	59	62	66	35	42	44	46	51	53	55	
		90	24	26	31	31	35	37	40	24	26	31	31	35	35	37	20	24	26	26	29	31	33	
		22	75	31	33	37	37	42	44	46	31	33	37	37	42	44	24	29	31	33	35	37	40	
		50	35	37	44	46	51	53	55	35	40	44	46	51	53	55	31	33	37	40	42	44	46	
<b>SUSTAINED FORCES (d)</b>																								
		7 foot push						25 foot push						50 foot push										
(a)	(b)	90	13	18	22	22	24	26	31	13	15	15	15	18	20	24	11	13	13	13	15	15	20	
		53	75	20	26	31	31	35	37	46	20	22	24	24	26	29	35	15	18	20	20	22	24	29
		50	26	35	41	44	46	51	62	26	31	31	33	35	37	46	22	24	26	26	31	31	40	
		90	13	15	20	20	22	24	29	13	15	18	18	20	20	24	11	13	13	15	15	18	22	
		35	75	18	24	29	29	33	35	42	20	22	24	24	29	29	37	15	18	20	22	24	31	
		50	24	33	40	40	44	46	57	26	29	33	33	37	40	48	20	24	29	29	31	33	42	
		90	11	13	18	18	20	20	26	13	15	15	15	18	20	24	11	13	13	13	15	15	20	
		22	75	15	20	24	26	29	31	37	18	22	22	24	26	26	33	15	18	20	20	22	29	
		50	22	29	33	35	37	40	51	24	29	31	31	35	37	46	20	24	26	26	29	31	37	
<b>INITIAL FORCES (c)</b>																								
		100 foot push						150 foot push						200 foot push										
(a)	(b)	90	–	–	26	29	31	33	37	–	–	26	29	31	33	37	–	–	–	26	29	31	33	
		53	75	–	–	33	35	37	42	46	–	–	33	35	37	42	46	–	–	–	31	33	37	42
		50	–	–	40	42	46	48	55	–	–	40	42	46	48	55	–	–	–	37	40	44	48	
		90	–	–	26	31	33	35	40	–	–	26	31	33	35	40	–	–	–	26	29	31	35	
		35	75	–	–	33	35	40	42	46	–	–	33	35	40	42	46	–	–	–	33	35	37	42
		50	–	–	40	44	46	51	57	–	–	40	44	46	51	57	–	–	–	40	42	44	51	
		90	–	–	24	26	26	29	33	–	–	24	26	26	29	33	–	–	–	22	24	26	29	
		22	75	–	–	29	31	33	35	40	–	–	29	31	33	35	40	–	–	–	26	29	31	35
		50	–	–	33	37	40	42	48	–	–	33	37	40	42	48	–	–	–	33	35	37	42	
<b>SUSTAINED FORCES (d)</b>																								
		100 foot push						150 foot push						200 foot push										
(a)	(b)	90	–	–	11	13	13	13	18	–	–	11	11	11	13	18	–	–	–	9	9	9	13	
		53	75	–	–	15	18	20	20	26	–	–	15	18	18	18	24	–	–	–	13	13	13	20
		50	–	–	22	24	26	26	35	–	–	20	22	24	24	33	–	–	–	18	18	20	26	
		90	–	–	11	13	13	15	20	–	–	11	13	13	13	18	–	–	–	9	9	11	13	
		35	75	–	–	18	20	20	22	29	–	–	15	18	18	20	26	–	–	–	13	13	15	20
		50	–	–	22	26	26	29	37	–	–	22	24	24	26	35	–	–	–	18	20	20	26	
		90	–	–	11	13	13	13	18	–	–	11	11	11	13	15	–	–	–	9	9	9	13	
		22	75	–	–	15	18	18	20	26	–	–	15	15	18	18	24	–	–	–	13	13	13	18
		50	–	–	22	24	24	26	35	–	–	20	22	22	24	33	–	–	–	18	18	18	24	

**NOTES:**

- a) Vertical distance from floor to hands (inches)
- b) Percent of industrial population capable of performing push without excessive stress
- c) The force required to start an object into motion
- d) The force required to keep an object in motion
- \*) Rounded from original metric study

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**Table D.7 – Maximum acceptable forces of pull for males and females (pounds-force\*)**

		One pull every						One pull every						One pull every									
		6	12	1	2	5	30	8	15	22	1	2	5	30	8	25	35	1	2	5	30	8	
		sec		min				hr	sec		min				hr	sec		min				hr	
<b>Males – INITIAL FORCES (c)</b>																							
		7 foot pull						25 foot pull						50 foot pull									
(a)	(b)	90	31	35	40	40	42	42	51	24	29	35	35	37	40	46	29	33	33	33	35	37	44
		75	37	42	48	48	51	43	62	31	33	44	44	46	46	57	35	40	42	42	44	44	53
		50	44	51	57	57	62	62	73	35	40	53	53	55	57	68	42	46	48	48	53	53	64
		90	42	48	55	55	59	59	70	33	40	51	51	52	53	64	40	44	46	46	51	51	62
		75	51	59	68	68	70	73	86	42	46	62	62	64	66	79	48	55	57	57	62	62	73
		50	62	70	79	79	86	86	103	51	57	73	73	77	77	92	57	64	68	68	73	73	88
		90	48	55	62	62	66	66	79	40	44	57	57	59	62	73	44	51	53	53	57	57	68
		75	59	66	75	75	81	81	97	46	53	68	68	73	75	88	53	62	64	64	68	70	84
		50	70	79	90	90	97	97	117	55	64	81	81	88	88	106	64	73	77	77	81	84	99
<b>Males –SUSTAINED FORCES (d)</b>																							
		7 foot pull						25 foot pull						50 foot pull									
(a)	(b)	90	18	22	26	29	33	33	40	13	18	22	24	26	26	33	15	18	20	20	22	24	29
		75	22	29	35	37	42	44	51	28	22	29	31	35	35	42	20	22	26	26	31	31	37
		50	29	35	44	46	51	53	62	22	29	35	37	42	44	51	24	29	31	33	37	37	44
		90	22	29	35	37	42	44	53	18	22	29	31	35	35	42	20	22	26	26	31	31	37
		75	29	37	46	48	55	57	66	24	29	37	40	44	46	55	24	31	33	33	40	40	48
		50	35	46	57	59	68	70	81	29	37	46	48	55	57	68	31	37	42	42	48	51	59
		90	24	31	37	40	44	46	55	20	24	31	33	37	37	44	20	24	26	29	33	33	40
		75	31	42	51	51	57	59	70	24	31	42	42	48	48	57	26	31	35	37	42	42	51
		50	37	51	62	64	70	75	88	31	40	51	53	59	62	73	33	40	44	46	51	59	62
<b>Females – INITIAL FORCES (c)</b>																							
		7 foot pull						25 foot pull						50 foot pull									
(a)	(b)	90	29	35	37	40	44	46	48	29	31	35	35	40	42	44	22	26	29	31	33	35	37
		75	35	42	44	46	53	55	57	35	37	42	42	46	48	53	26	31	35	35	40	42	44
		50	42	48	53	55	62	64	68	42	44	48	51	55	57	62	31	35	42	42	46	58	53
		90	31	35	40	42	46	48	51	31	33	35	37	42	44	46	22	26	31	31	35	37	40
		75	35	42	46	48	53	57	59	37	40	42	44	48	51	55	26	33	37	37	42	44	45
		50	42	51	55	57	64	66	70	42	46	51	53	57	59	64	31	37	42	44	48	51	55
		90	33	37	42	44	46	51	53	33	35	37	40	44	46	48	24	29	33	33	37	40	42
		75	37	44	48	51	57	59	62	37	42	44	56	51	53	57	29	33	37	40	44	46	48
		50	44	53	57	59	68	70	73	44	48	53	55	62	64	66	33	40	44	48	51	53	57
<b>Females – SUSTAINED FORCES (d)</b>																							
		7 foot pull						25 foot pull						50 foot pull									
(a)	(b)	90	13	20	22	22	24	26	33	15	18	20	20	22	24	29	13	15	15	18	18	20	24
		75	18	26	29	31	33	35	44	20	24	26	26	29	31	40	15	20	22	22	24	26	33
		50	22	35	37	40	42	46	55	26	29	33	35	37	40	48	20	24	29	29	31	33	42
		90	13	20	22	22	24	26	31	15	18	20	20	22	22	29	11	13	15	15	18	20	24
		75	18	26	29	29	33	35	42	20	22	24	26	29	31	37	15	18	22	22	24	26	31
		50	22	33	35	37	42	44	55	24	29	33	33	35	40	48	20	24	28	29	31	33	40
		90	11	18	20	20	22	24	29	13	15	18	18	20	22	26	11	13	15	15	15	18	22
		75	15	24	26	26	29	31	40	18	20	24	24	26	29	35	15	18	20	20	22	24	29
		50	20	31	33	35	37	40	51	22	26	29	31	33	35	44	18	22	24	26	29	31	37

**NOTES:**

- a) Vertical distance from floor to hands (inches)
- b) Percent of industrial population capable of performing pull without excessive stress
- c) The force required to start an object into motion
- d) The force required to keep an object in motion
- \*) Rounded from original metric study

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**Table D.8 – Maximum acceptable weight of carry for males and females (pounds-force\*)**

		One carry every					One carry every					One carry every											
		6	12	1	2	5	30	8	15	22	1	2	5	30	8	25	35	1	2	5	30	8	
		sec	min				hr	sec	min				hr	sec	min				hr				
<b>Males</b>																							
		7 foot carry					14 foot carry					28 foot carry											
(a)	(b)	90	22	31	37	37	42	46	55	20	24	33	33	37	42	48	20	24	29	29	33	37	44
44	75	31	42	51	51	57	64	75	29	35	46	46	51	57	66	29	33	40	40	44	51	59	
	50	42	55	66	66	73	84	97	37	44	59	59	66	75	86	37	42	51	53	57	64	77	
31	90	29	37	46	46	51	57	68	24	31	40	42	46	51	59	29	33	37	40	44	48	57	
	75	40	51	62	64	70	79	92	35	42	55	55	62	70	81	37	44	53	53	59	66	77	
	50	51	66	81	81	90	101	119	44	55	70	73	79	90	106	48	57	68	68	77	86	101	
<b>Females</b>																							
		7 foot carry					14 foot carry					28 foot carry											
(a)	(b)	90	24	26	29	29	29	29	40	20	22	29	29	29	29	40	22	24	26	26	26	26	35
41	75	29	31	33	33	35	35	46	24	26	33	33	35	35	46	29	29	31	31	31	31	42	
	50	33	35	40	40	40	40	55	26	29	40	40	40	40	53	31	33	35	35	35	35	48	
28	90	26	31	35	35	35	35	48	22	24	31	31	31	31	44	26	26	31	31	31	34	42	
	75	33	37	40	40	42	42	55	24	29	35	35	37	37	51	31	33	35	35	37	37	51	
	50	37	42	46	46	48	48	64	29	33	42	42	44	44	57	35	37	42	42	44	44	57	

**NOTES:**

- a) Vertical distance from floor to hands (inches)
- b) Percent of industrial population capable of carrying without excessive stress
- \*) Rounded from original metric study

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