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Truck Ability Prediction Procedure

SAE Recommended Practice
Revised August 1987

Submitted for Recognition as an American National Standard

SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®

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TRUCK AND BUS PRACTICE

SAE J688

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TRUCK ABILITY PREDICTION PROCEDURE

1. INTRODUCTION:

The procedure has been developed to provide a practical method for the prediction of truck performance using accepted data. It is designed to help anyone concerned with the problem of truck selection.

By following directions, it is possible to determine the necessary information for intelligent truck selection without being concerned with the origin or derivation of the complex factors involved. With readily available specifications of a truck, information provided in the tables, and a minimum of calculation, it is possible to predict:

(a) The performance obtainable from a truck of given characteristics under given operating conditions.
(b) The characteristics required in a truck to meet different performance requirements under given operating conditions.

Ed. This report comprises a procedure form and 10 tables of data. A complete explanation of the truck ability prediction procedure is contained in SAE Technical Report HS-82, Truck Ability-Prediction Procedure. Part 1 of HS-82 contains, in addition to the procedure form and tables, work sheets and an example. Part 2 demonstrates by practical examples how to obtain some of the answers other than grade ability, and presents a detailed procedure for computing instantaneous acceleration and the time or distance required to accelerate between specified limits of speed. Part 3 gives terminology, the fundamental relations, and the formulas which form the basis for the procedure, a discussion of the reliability of factors and methods, and presents a method for evaluating the effect of wind on air resistance.

TABLE 1 - Tire Factor

Tubeless Tire Size	Conventional Tire Size	Ply Rating	Tire Factor
6.00-16	6.00-16	6	12.40
6.50-16	6.50-16	6	11.85
7-17.5	7.00-15, 7.00-16	6	11.75
7-17.5	7.00-15, 7.00-16	8	11.75
7-22.5	6.50-20	6	10.15
7-22.5	6.50-20, 7.00-20	8	10.15
8-17.5	7.00-16, 7.50-15 7.50-16	6	11.45
8-17.5	7.00-16, 7.50-15 7.50-16	8	11.45
8-19.5	7.00-17, 7.50-17	6	10.50
8-19.5	7.00-17, 7.50-17	8	10.50
8-22.5	7.50-20	8	9.50
8-22.5	7.50-20	10	9.50
9-22.5	8.25-20	10	9.20
9-22.5	8.25-20	12	9.20
10-22.5	9.00-20	10	8.80
10-22.5	9.00-20	12	8.80
11-22.5	10.00-20	12	8.55
11-22.5	10.00-20	14	8.55
11-24.5	10.00-22	12	8.15
12.00-21	12.00-20	14	8.05
12.00-25	12.00-24	14	7.35
12-22.5	11.00-20	12	8.30
12-22.5	11.00-20	14	8.30
12-24.5	11.00-22	12	7.90
12-24.5	11.00-22	14	7.90
13.00-21	13.00-20	16	7.75
13.00-25	13.00-24	16	7.10
14.00-21	14.00-20	16	7.35
14.00-24	14.00-24	16	6.75

$$\text{Tire Factor} = \frac{168}{\text{Loaded Radius}}$$

TABLE 2 - Altitude Factor (For Net HP Correction)

Altitude, ft	Altitude Factor	Altitude, ft	Altitude Factor
0	1.00	8,000	0.68
1,000	0.96	9,000	0.64
2,000	0.92	10,000	0.60
3,000	0.88	11,000	0.56
4,000	0.84	12,000	0.52
5,000	0.80	13,000	0.48
6,000	0.76	14,000	0.44
7,000	0.72	15,000	0.40

PROCEDURE FORM FOR DETERMINING GRADE ABILITY
AT A GIVEN ROAD SPEED AND EQUIVALENT ACCELERATION RATE

Data Pertaining to Vehicle and Conditions of Operation

Item
1. Vehicle identification [Make, model and type of vehicle(s)]
2. Vehicle overall maximum dimensions (a) Height ..... ft (b) Width ..... ft
3. Total gross weight in thousand lb .....
4. Manufacturer's maximum gross vehicle weight rating for power unit in pounds .....
5. Gear ratios (a) Transmission ..... (b) Auxiliary transmission ..... (c) Axle .....
(d) Total gear reduction .....
6. Tire size (driving wheels) .....
7. Net engine power at sea level (a) ..... hp at (b) ..... rpm engine speed
8. Altitude ..... ft
9. Road surface type and condition .....

PROCEDURE

Steps	Procedure	Value
1. Apparent road speed in mph[a]	$\frac{\text{(Item 7b)}}{\text{(Item 5d)} \times \left(\frac{\text{Tire factor,}}{\text{Table 1}}\right)}$	
2. Net engine hp corrected for altitude	$\left(\frac{\text{Altitude factor,}}{\text{Table 2}}\right) \times$ (Item 7a)	
3. Rolling resistance hp	$\left(\frac{\text{Rolling Factor,}}{\text{Table 3}}\right) \times$ (Item 3)	
4. Air resistance hp	$\left(\frac{\text{Area Factor,}}{\text{Table 4}}\right) \times \left(\frac{\text{Velocity factor,}}{\text{Table 5}}\right) \times \left(\frac{\text{Altitude Factor,}}{\text{Table 6}}\right)$	
5. Chassis Friction hp	(Chassis factor, Table 7)	
6. Level road hp	Sum of values 3, 4 and 5	
7. Reserve hp[b]	(Value 2) minus (Value 6)	
8. Grade resistance hp per 1000 lb weight	$\frac{\text{(Value 7)}}{\text{(Item 3)}}$	
9. Grade ability on Class 1 roads (good)[c]	(Value 8) $\times \left(\frac{\text{Grade factor,}}{\text{Table 8}}\right)$	
10. Grade deduction for road type and condition	(Road factor, Table 9)	
11. Net grade ability at apparent road speed[b]	(Value 9) minus (Value 10)	
12. Approximate acceleration rate on level at apparent road speed in mph per sec (total gear reduction less than 10.0)	(0.2) X (Value 11)	

[a]Apparent road speed can be attained under given conditions only if sufficient net hp is available.
[b]If this value is negative, the net hp is insufficient to attain apparent road speed.
[c]Correct value using Table 8A if 20% or above.

TABLE 3 - Rolling Factor

mph	Rolling factor	mph	Rolling factor	mph	Rolling factor	mph	Rolling factor	mph	Rolling factor	mph	Rolling factor	mph	Rolling factor	mph	Rolling factor	mph	Rolling factor
1	0.020	11	0.252	21	0.531	31	0.859	41	1.234	51	1.658	61	2.129	71	2.649
2	0.041	12	0.278	22	0.562	32	0.894	42	1.275	52	1.703	62	2.179	72	2.703
3	0.063	13	0.304	23	0.593	33	0.930	43	1.315	53	1.748	63	2.229	73	2.758
4	0.085	14	0.331	24	0.625	34	0.967	44	1.356	54	1.794	64	2.280	74	2.814
5	0.107	15	0.358	25	0.657	35	1.003	45	1.398	55	1.841	65	2.331	75	2.870
6	0.130	16	0.386	26	0.689	36	1.041	46	1.440	56	1.888	66	2.383	76	2.927
7	0.154	17	0.414	27	0.722	37	1.078	47	1.483	57	1.935	67	2.435	77	2.983
8	0.177	18	0.443	28	0.756	38	1.117	48	1.526	58	1.983	68	2.488	78	3.041
9	0.202	19	0.472	29	0.790	39	1.155	49	1.569	59	2.031	69	2.541	79	3.099
10	0.227	20	0.501	30	0.824	40	1.195	50	1.613	60	2.080	70	2.595	80	3.157

$$\text{Rolling factor} = \frac{(7.6 + 0.09\ \text{mph}) \times \text{mph}}{375}$$

TABLE 4 - Area Factor

Maximum Vehicle Height, ft	Max Vehicle Width, ft						
	5	5-1/2	6	6-1/2	7	7-1/2	8
5	0.057	0.062	0.068	0.074	0.079	0.085	0.091
5-1/2	0.063	0.070	0.076	0.082	0.089	0.095	0.101
6	0.070	0.077	0.084	0.091	0.098	0.105	0.112
6-1/2	0.077	0.084	0.092	0.100	0.107	0.115	0.123
7	0.083	0.092	0.100	0.108	0.117	0.125	0.133
7-1/2	0.090	0.099	0.108	0.117	0.126	0.135	0.144
8	0.097	0.106	0.116	0.126	0.135	0.145	0.155
8-1/2	0.103	0.114	0.124	0.134	0.145	0.155	0.165
9	0.110	0.121	0.132	0.143	0.154	0.165	0.176
9-1/2	0.117	0.128	0.140	0.152	0.163	0.175	0.187
10	0.123	0.136	0.148	0.160	0.173	0.185	0.197
10-1/2	0.130	0.143	0.156	0.169	0.182	0.195	0.208
11	0.137	0.150	0.164	0.178	0.191	0.205	0.219
11-1/2	0.143	0.158	0.172	0.186	0.201	0.215	0.229
12	0.150	0.165	0.180	0.195	0.210	0.225	0.240
12-1/2	0.157	0.172	0.188	0.204	0.219	0.235	0.251
13	0.163	0.180	0.196	0.212	0.229	0.245	0.261
13-1/2	0.170	0.187	0.204	0.221	0.238	0.255	0.272

$$\text{Area Factor} = \frac{(\text{height} - 3/4) \times \text{width}}{375}$$

TABLE 5 -Velocity Factor

mph	Velocity Factor	mph	Velocity Factor	mph	Velocity Factor	mph	Velocity Factor
1	0.00	21	18.5	41	138	61	454
2	0.02	22	21.3	42	148	62	477
3	0.05	23	24.3	43	159	63	500
4	0.13	24	27.6	44	170	64	524
5	0.25	25	31.3	45	182	65	549
6	0.43	26	35.1	46	195	66	575
7	0.69	27	39.4	47	208	67	601
8	1.02	28	43.9	48	221	68	629
9	1.46	29	48.8	49	235	69	657
10	2.00	30	54.0	50	250	70	686
11	2.66	31	59.6	51	265	71	716
12	3.46	32	65.5	52	281	72	746
13	4.39	33	71.9	53	298	73	778
14	5.49	34	78.6	54	315	74	810
15	6.75	35	85.7	55	333	75	844
16	8.19	36	93.3	56	351	76	878
17	9.83	37	101	57	370	77	913
18	11.7	38	110	58	390	78	949
19	13.7	39	119	59	411	79	986
20	16.0	40	128	60	432	80	1024

Velocity factor = $0.002\ (mph)^3$

TABLE 6 - Altitude Factor
(For Air Resistance)

Altitude, ft	Altitude Factor
0	1.00
1,000	0.97
2,000	0.94
3,000	0.91
4,000	0.89
5,000	0.86
6,000	0.83
7,000	0.81
8,000	0.78
9,000	0.76
10,000	0.74
11,000	0.71
12,000	0.69
13,000	0.67
14,000	0.65
15,000	0.63

TABLE 7 - Chassis Friction Horsepower[a]

Manufacturer's Max Gross Vehicle Weight Rating of Power Unit	Engine rpm													
	800	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000	3200	3400
10,000	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.8	6.2	6.6	7.0	7.4	7.8
11,000	2.7	3.2	3.6	4.1	4.5	4.9	5.4	5.8	6.3	6.7	7.1	7.6	8.0	8.5
12,000	2.9	3.4	3.9	4.4	4.8	5.3	5.8	6.3	6.8	7.2	7.7	8.2	8.7	9.2
13,000	3.0	3.6	4.1	4.6	5.1	5.6	6.2	6.7	7.2	7.7	8.2	8.8	9.3	9.8
14,000	3.2	3.8	4.4	4.9	5.5	6.0	6.6	7.2	7.7	8.3	8.8	9.4	10.0	10.5
15,000	3.4	4.0	4.6	5.2	5.8	6.4	7.0	7.6	8.2	8.8	9.4	10.0	10.6	11.2
16,000	3.6	4.2	4.8	5.5	6.1	6.8	7.4	8.0	8.7	9.3	10.0	10.6	11.2	11.9
17,000	3.7	4.4	5.0	5.7	6.4	7.1	7.8	8.4	9.1	9.8	10.6	11.2	11.8	12.5
18,000	3.9	4.6	5.3	6.0	6.8	7.5	8.2	8.9	9.6	10.4	11.1	11.8	12.5	13.2
19,000	4.0	4.8	5.5	6.3	7.1	7.8	8.6	9.3	10.1	10.9	11.6	12.4	13.1	13.9
20,000	4.2	5.0	5.8	6.6	7.4	8.2	9.0	9.8	10.6	11.4	12.2	13.0	13.8	14.6
22,000	4.5	5.4	6.3	7.1	8.0	8.9	9.8	10.7	11.5	12.4	13.2	14.2	15.1	15.9
24,000	4.8	5.8	6.8	7.7	8.7	9.6	10.6	11.6	12.5	13.5	14.4	15.4	16.4	17.3
26,000	5.1	6.2	7.2	8.2	9.3	10.3	11.4	12.4	13.4	14.5	15.5	16.6	17.6	18.6
28,000	5.5	6.6	7.7	8.8	9.9	11.1	12.2	13.3	14.4	15.5	16.7	17.8	18.9	20.0
30,000	5.8	7.0	8.2	9.4	10.5	11.8	13.0	14.2	15.4	16.5	17.8	19.0	20.2	21.3
32,000	6.1	7.4	8.7	10.0	11.2	12.5	13.8	15.1	16.4	17.6	18.9	20.2	21.5	22.7
36,000	6.8	8.2	9.6	11.1	12.5	13.9	15.4	16.8	18.3	19.7	21.2	22.6	24.0	25.5
40,000	7.4	9.0	10.6	12.2	13.8	15.4	17.0	18.6	20.2	21.8	23.4	25.0	26.6	28.2
45,000	8.2	10.0	11.8	13.6	15.4	17.2	19.0	20.8	22.6	24.4	26.2	28.0	29.8	31.6
50,000	9.0	11.0	13.0	15.0	17.0	19.0	21.0	23.0	25.0	27.0	29.0	31.0	33.0	35.0
60,000	10.6	13.0	15.4	17.8	20.2	22.6	25.0	27.4	29.8	32.2	34.6	37.0	39.4	41.8

[a]These values are tentative and apply only to rear wheel driven vehicles.

TABLE 8 - Grade Factor
(use with correction Table 8A for grades over 20%)

mph	Grade Factor	mph	Grade Factor	mph	Grade Factor	mph	Grade Factor
1	37.50	21	1.78	41	0.91	61	0.61
2	18.75	22	1.70	42	0.89	62	0.60
3	12.50	23	1.63	43	0.87	63	0.60
4	9.38	24	1.56	44	0.85	64	0.59
5	7.50	25	1.50	45	0.83	65	0.58
6	6.25	26	1.44	46	0.82	66	0.57
7	5.36	27	1.39	47	0.80	67	0.56
8	4.68	28	1.34	48	0.78	68	0.55
9	4.17	29	1.29	49	0.77	69	0.54
10	3.75	30	1.25	50	0.75	70	0.54
11	3.41	31	1.21	51	0.74	71	0.53
12	3.12	32	1.17	52	0.72	72	0.52
13	2.88	33	1.14	53	0.71	73	0.51
14	2.68	34	1.10	54	0.69	74	0.51
15	2.50	35	1.07	55	0.68	75	0.50
16	2.34	36	1.04	56	0.67	76	0.49
17	2.20	37	1.01	57	0.66	77	0.49
18	2.08	38	0.99	58	0.65	78	0.48
19	1.97	39	0.96	59	0.64	79	0.47
20	1.87	40	0.94	60	0.62	80	0.47

$$\text{Grade factor} = \frac{37.5}{\text{mph}}$$

TABLE 8A - Correction for Values of
Grade Ability Above 20%

Computed Grade Ability	Corrected Grade Ability	Computed Grade Ability	Corrected Grade Ability
20	20.4	37	39.8
21	21.5	38	41.1
22	22.6	39	42.4
23	23.6	40	43.6
24	24.7	41	45.0
25	25.8	42	46.3
26	26.9	43	47.6
27	28.0	44	49.0
28	29.2	45	50.4
29	30.3	46	51.8
30	31.5	47	53.2
31	32.6	48	54.7
32	33.8	49	56.2
33	35.0	50	57.7
34	36.2	51	59.3
35	37.4	52	60.9
36	38.8		