



SURFACE VEHICLE RECOMMENDED PRACTICE

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Commercial Truck and Bus SAE Recommended Procedure
for Vehicle Performance Prediction and Charting

RATIONALE

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FOREWORD

This procedure is the recommended replacement for SAE J688 Truck Ability Procedure. It includes recommended graphic representations of vehicle steady-state performance, with mathematical equations and recommended constants for various configurations of commercial vehicle components, systems, and vocational environments. It may also be used instead of SAE J688, as a standardized form for summarizing and presenting comparative vehicle steady-state performance in bids and tenders. A proposed worksheet for bids and tenders is included (see Appendix A).

1. SCOPE

This SAE Recommended Practice takes into account modern standardized methods for collecting and summarizing data that has an effect on vehicle steady-state performance, such as engine output (gross and net), transmission losses, drivetrain efficiency, vehicle aerodynamic devices for various vehicle and body configurations, as well as road surface variations and air density variations resulting from altitude and barometric effects. The procedure does not address vehicle transient performance (acceleration, braking, and cornering), because of the considerable amount of additional data required such as moment of inertia of all the rotating parts. Nor does it address vehicles with torque converters and automatic transmissions. This document is, therefore, intended for vehicles having fixed-ratio type transmissions and positive engagement clutches. Metric and ISO unit conversions are provided in the metric conversion tables at the end of this procedure (see Appendix B).

Some modern vehicles with electronic engine controls have the ability to vary the maximum engine revolutions for each gear, as well as permitting the power or rpm to increase if more time is spent in the lower gears, as when climbing a grade. These special cases can be handled by this procedure, just by customizing the data for each transmission ratio and superimposing the long-term data on top of the instantaneous data.

All of the equations are written in a form suitable for programming into a mainframe or desk-top computer, using a spreadsheet/database or a higher level language, such as Basic, Fortran, Pascal, C or Unix, etc. However, they are simple enough, to be performed on a hand-held calculator.

2. REFERENCES

2.1 Applicable Documents

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

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J688 Truck Ability Prediction Procedure

SAE J1489 Heavy Truck and Bus Retarder Downhill Performance Mapping Procedure

2.2 Other Publications

Tables and Formulas for the Automotive Engineer (reference 6-67 - BCR 10M), Clark Equipment Company

3. TECHNICAL DATA

The following diagrams represent a recommended standard format for illustrating vehicle performance with tables and graphs. They also represent a recommended standardized form for presenting vehicle performance in a general manner. It should be recognized that there are special vehicles, powertrains, and operating conditions that may require a different form of presentation, such as those presented in SAE J1489 Vehicle Downhill Performance Mapping Procedure.

4. ENGINE SPEED VERSUS ROAD SPEED

(See Figure 1.)

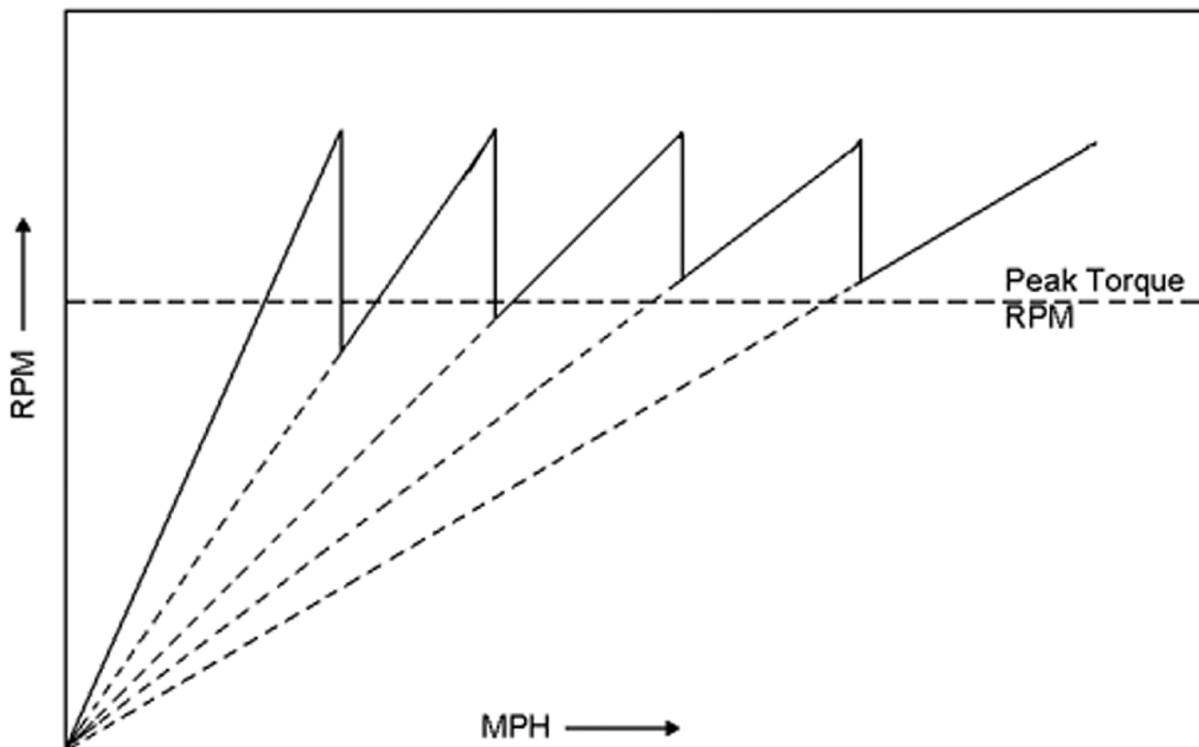


Figure 1 - Engine speed versus road speed



For vehicles having stepped transmissions with positive engagement friction clutches, the co-ordinate of the point of rated engine speed (or full power governed engine speed) versus the maximum vehicle speed for each gear ratio is defined by Equation 1:

$$V_{GN(max)} = \frac{N_{RA} \times 60}{M \times R_G} \quad (\text{Eq. 1})$$

The co-ordinates of the interception point or downshift engine speed are defined as follows in Equation 2:

$$V_{(G-1)N(max)} = \frac{N_{RA} \times 60}{M \times R_{(G-1)}}$$

$$N_S = N_{RA} \times \frac{R_G}{R_{(G-1)}} \quad (\text{Eq. 2})$$

5. PERCENT GRADEABILITY VERSUS VEHICLE SPEED

(See Figure 2 and Equations 3 and 4.)

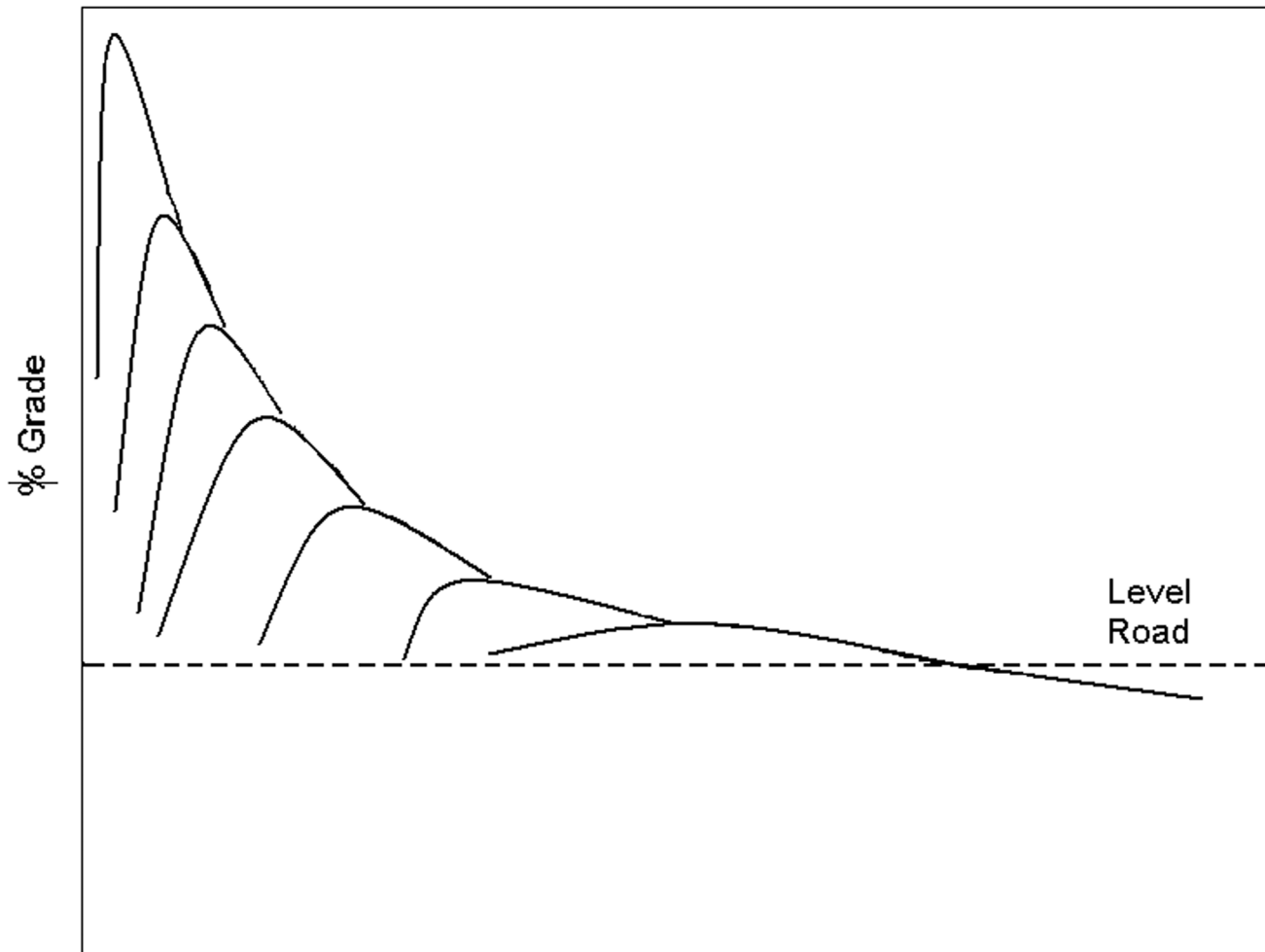


Figure 2 - Percent gradeability versus vehicle speed

$$V_{GN} = \frac{N \times 60}{M \times R_G} \quad (\text{Eq. 3})$$

$$P_{GN} = 100 \times \tan \left[\sin^{-1} \left(375 \times \frac{HP_N \times E_G - (WP_R + WP_A)}{W \times V_{GN}} \right) \right] \quad (\text{Eq. 4})$$

1 hp = 0.7457 kW

1 kW = 1.1341 hp

where:

$$WP_R = \frac{W \times (RC_1 + RC_2 \times V) \times SC \times V}{375 \times 1000}$$

$$WP_A = \frac{C_D \times C_A \times FA \times V^3 \times 0.0024}{375}$$

6. LIMITING GRADE FOR WHEEL SLIP

(See Figure 3.)

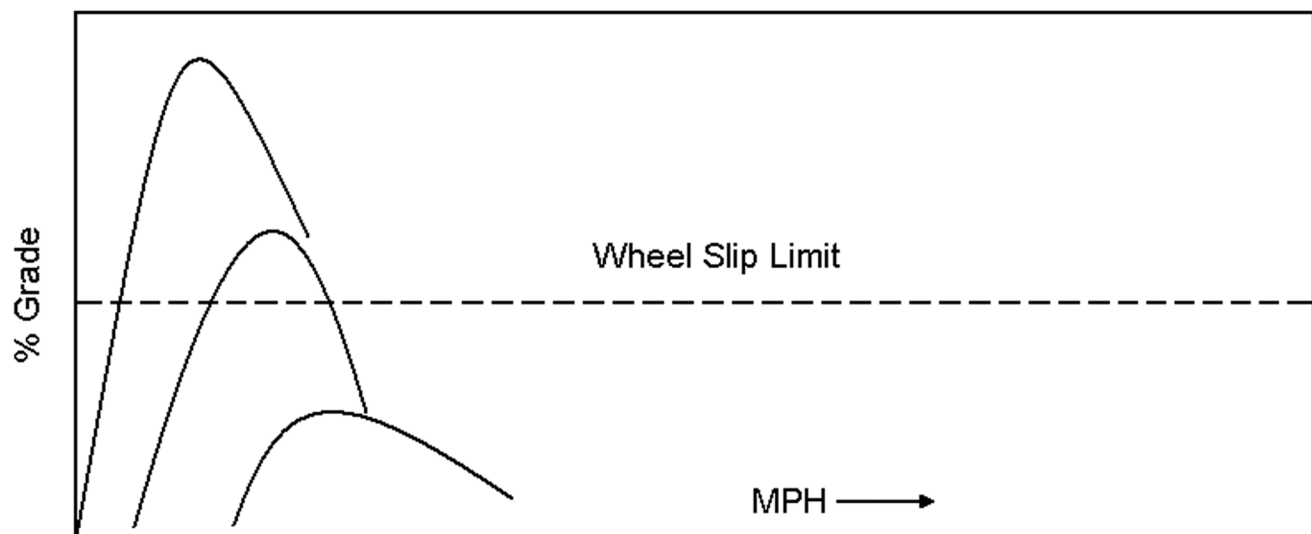


Figure 3 - Limiting grade for wheel slip

Figure 3 represents the maximum steady-state gradeability that can be achieved for a given vehicle combination and road surface. It can be represented by Equation 5:

$$P_S = \frac{W_{DA} \times C_T \times 100}{W} \quad (\text{Eq. 5})$$

7. WHEEL POWER VERSUS VEHICLE SPEED

(See Figure 4.)

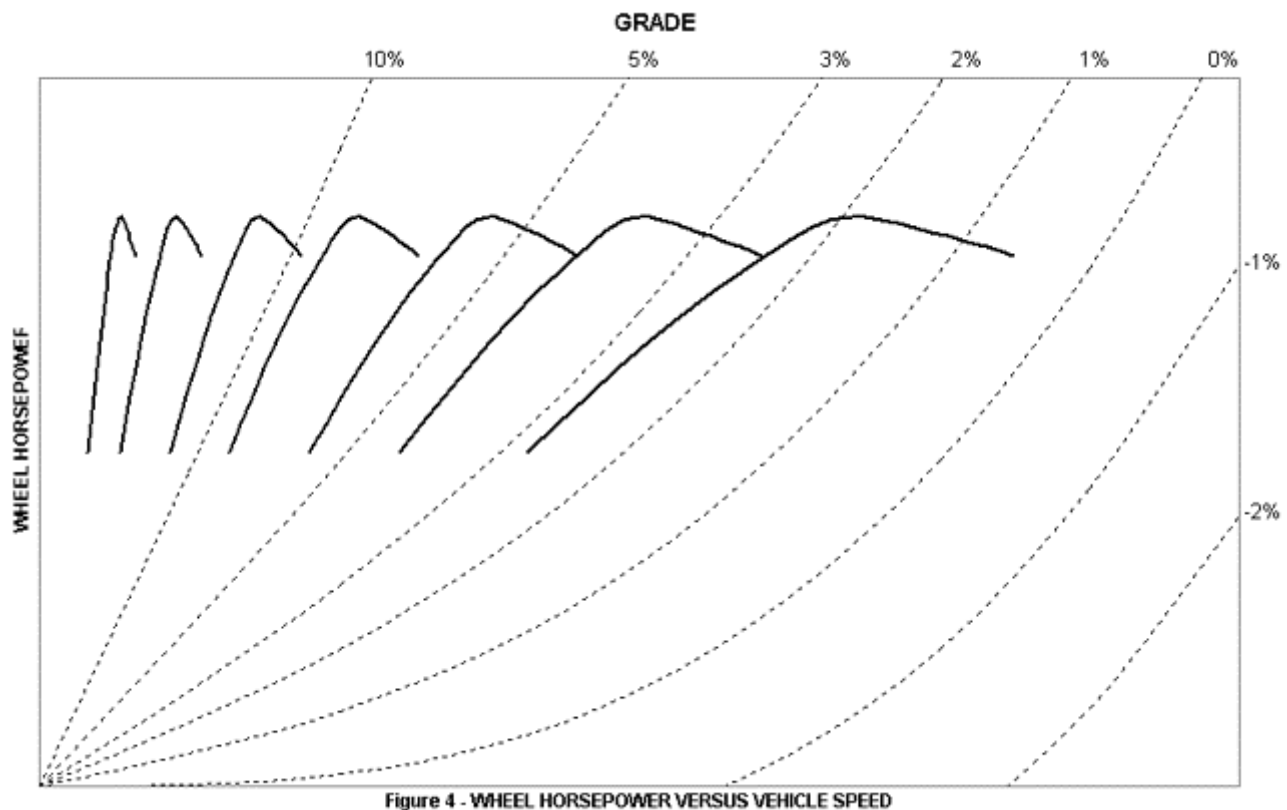


Figure 4 - Wheel power versus vehicle speed

Figure 4 represents the wheel power exchange on the vehicle. It can be broken down into two major components, as follows:

- Wheel Power available from the vehicle drivetrain in various gears and at specified engine speed.
- Wheel Power required for given speed, tire/road surface interaction, vehicle weight, aerodynamic drag, and grade conditions.

The Wheel Power available is defined in Equation 6:

$$WP_{GN} = \frac{HP_N \times E_G}{100} \quad (\text{Eq. 6})$$

The vehicle speed component is the same as for the previous chart, as follows in Equation 7:

$$V_{GN} = \frac{N \times 60}{M \times R_G} \quad (\text{Eq. 7})$$