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Technical Support Report for Regulatory Action

Light Duty Vehicle Road Load Determination

by

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U.S. Environmental Protection Agency

Abstract

When vehicle exhaust emission tests or vehicle fuel consumption measurements are performed on a chassis dynamometer, the dynamometer is usually adjusted to simulate the road experience of the vehicle. Specifically, if the dynamometer measurements are to accurately reflect on-road operation of the vehicle, the dynamometer must supply the appropriate load; that is, the force required to drive the vehicle on a level surface as a function of the vehicle speed. In this study, road load versus speed data were obtained from 64 light duty vehicles. The coast down technique, in which the forces acting on a freely decelerating vehicle are deduced from the speed-time history of the deceleration, was used for all track measurements.

When a vehicle is operated on a chassis dynamometer, the vehicle must overcome the dissipative losses of the drive train and tires before power is transmitted to the dynamometer. Therefore, to derive a dynamometer setting appropriate to simulate the road experience of a vehicle, these losses must be subtracted from the total system losses measured on the track. Measurements of the dissipative forces of the driving tires, the drive train, the non-driving tires, and the non-driving wheel bearings were performed on a 48 inch diameter single roll electric dynamometer.

The dynamometer load settings, resulting from the subtraction of the dissipative losses of the drive train and the driving tires from the total system measurements, are presented. These data are regressed against vehicle mass to develop equations to predict the dynamometer load settings. This equation is then compared with the current light duty vehicle dynamometer adjustment table. The current table is correct, at least within the accuracy of the tire-roll interaction assumptions. It is concluded that while the current table is approximately correct for an average vehicle, significant deviations can exist between any prediction system based on vehicle weight and specific vehicles. It is therefore concluded that further effort should be made to develop road load prediction systems based on vehicle frontal area and, if necessary, estimates of the vehicle aerodynamic drag coefficient.

I. Purpose

The purpose of this study is to develop equations to predict the dynamometer adjustment forces appropriate to simulate the on road experiences of light duty vehicles. To accomplish this, equations of road load versus speed were obtained from a diverse class of light duty vehicles. These data were then converted to dynamometer adjustment forces appropriate to simulate the on road experience of a vehicle.

II. Introduction

When vehicle exhaust emission tests or vehicle fuel consumption measurements are performed on a chassis dynamometer, the dynamometer is usually adjusted to simulate the road experience of the vehicle. Specifically the dynamometer must simulate the road load of the vehicle. In this report the vehicle road load is defined as the component of force in the direction of vehicle motion which is exerted by the road on the vehicle driving wheels. As defined, the road load force is the force which propells the vehicle. In the standard case, when a vehicle is moving with a constant velocity vector on a level surface, this force is equal in magnitude to the sum of the rolling resistance and the aerodynamic drag of the vehicle. Unfortunately, neither this road-tire force, nor the equal magnitude tire-road force can be directly measured because of the virtual impossibility of instrumenting the tire-road interface. Consequently, all experimental methods involve indirect measurements and some corrective process.

Commonly used methods for road-load determination are: the deceleration or coast down technique, drive line force or torque measurements, and manifold pressure measurements. The coast down method was selected as the approach best suited for this study since a method easily adaptable to a diverse class of vehicles was required. The concept of the coast down technqiue is to determine the rate of deceleration of a freely coasting vehicle; then, knowing the mass of the vehicle, the road-load force may be calculated by Newton's second law, $f = ma$. Previous experimental work at the EPA has demonstrated similar results are obtained with the coast down technique and with drive shaft torque meters.

Sixty-four diverse light duty vehicles were chosen as the experimental sample. These vehicles were chosen to approximately represent the sales weighting of light duty vehicles.

The track measurements include the dissipative losses of the vehicle tires, wheel bearings and drive train. To determine a road value appropriate for adjusting a chassis dynamometer, the dissipative losses from the drive train and driving tires must be subtracted from the total system measurements. These dissipative losses were measured using a 48" diameter roll electric dynamometer.

III. Discussion

This section discusses the specific physical measurements which must be performed to yield the dynamometer adjustment information. This section is included since some of the desired parameters must be determined indirectly; consequently the reason for some of the measurements may not be apparent.

The discussion is presented in three subsections. The system energy section discusses the general aspects of the problem and introduces the concept of equivalent effective mass. The track measurements determine the acceleration of the vehicle system. The mass measurements provide the information necessary to calculate forces or powers from the acceleration measurements.

A. System Energy

The introduction states that the vehicle mass and the vehicle deceleration under freely rolling conditions are the general parameters which must be obtained to determine road-load with the coast down technique. This section will discuss in detail what measurements must be performed to obtain these data.

The total energy of the decelerating vehicle system is the sum of the translational kinetic energy of the vehicle and the rotational kinetic energy of any vehicle components in rotational motion. For all mechanical components of the wheels and drive train, the rotational velocity is proportional to the vehicle velocity; therefore, the energy of the system may be written as:

$$E = 1/2\ mv^2 + 1/2\ (\sum_i I_i \alpha_i^2) v^2 \qquad (1)$$

Where:

- E = the total system energy
- m = the vehicle mass
- v = the vehicle speed
- I_i = rotational inertia of the i^{th} rotating component
- α_i = the proportionality constant between the rotational velocity of the i^{th} rotating component and the vehicle speed

Differentiating equation (1) with respect to time, and comparing the resulting expression for power with the similar time derivative of a purely translational system, the generalized force on the system may be expressed as:

$$F = (m + \sum_i I_i \alpha_i^2)A \quad (2)$$

Where:

F = the generalized system force
A = the translational acceleration of the system

Defining M as the "total effective mass of the system", where:

$$M = m + \sum_i I_i \alpha_i^2 \quad (3)$$

Equation (2) now has the familiar form

$$F = MA \quad (4)$$

The $\Sigma I_i \alpha_i^2$ term is identified as the "equivalent effective mass" of the rotating components and may be designated by:

$$m_{eq} = \Sigma I_i \alpha_i^2 \quad (5)$$

The equivalent effective mass, defined by equations (3) and (5), is simply one approach to include the effect of the rotational kinetic energy of the system. Equations (2) through (4) indicate that the acceleration of the system, the vehicle mass and the equivalent mass of the rotating components are the parameters which must be measured to determine the road load force.

B. Acceleration

Experimentally, it is not practical to measure the vehicle acceleration directly; however, the acceleration may be determined from the vehicle speed. The vehicle acceleration can be calculated by numerically differentiating the velocity versus time data. This is theoretically undesirable for two reasons. The non-analytical differentiation process is inherently noise sensitive and this can be a problem when attempting a least squares fit to the differentiated data. Also, since the acceleration must be derived from the velocity, the initially random errors in the velocity versus time data may not yield normally distributed errors in the acceleration versus velocity. A better approach is to assume a model for the acceleration versus speed equation and then perform analytical operations on this equation to convert it to the form of a speed versus time function. This expression may then be directly fitted to the velocity versus time data to obtain dv/dt as a function of vehicle velocity. The latter approach was chosen. The exact method used is an extension of the approach used by Korst and White[1], and is discussed in detail in reference 2.

C. Mass

The required masses are the gravitational mass and the equivalent effective mass of the rotating components. Equation (5) indicates that the rotational inertia is the primary measurement necessary to determine the equivalent effective mass of the rotating components.

1) Gravitational Mass

The gravitational mass of the system may be easily measured by a vehicle scale.

2) Effective Equivalent Mass of the Drive Wheels and Drive Train

The effective equivalent mass of the drive wheels and drive train was estimated by the equation:

$$m_{Deq} = 0.0155\ m \qquad (6)$$

where:

m_{Deq} = the effective equivalent mass of the drive train and drive tires

m = the vehicle mass

Equation (6) was developed by regressing the measurements of light duty vehicle drive train and driving tire inertia versus the vehicle mass. The vehicles used were a 50 vehicle subset of the vehicles used in this study. The measurements are described in reference 3. The standard error of this regression was 5.13. Therefore the 68% confidence interval of this regression is approximately $\pm$ 5 kg.

3) Effective Mass of the Vehicle Non-Driving Wheels

The effective mass of the vehicle non-driving wheels was estimated by:

$$m_{NDeq} = 1.055M_t \qquad (7)$$

where

m_{NDeq} = the total effective mass of the two vehicle non-driving wheels and tires

M_t = the mass of one vehicle tire and wheel assembly

The coefficient, 1.055, resulted from regressing rotational inertia measurements of tire-wheel assemblies versus the tire mass. The rotational inertia measurements were made using a three wire torsional pendulum, and are discussed in reference 4. The error of this regression, estimated in the same manner as the error of m_{Deq}, is $\pm$ 2.0 kg.

IV. Data Collection

This section discusses the test vehicles, the instrumentation used to collect the data and the test facilities.

Approximately 50 of the vehicles were selected on a sales weighted basis. The percentage of sales in each of the EPA Federal test procedure inertia categories was calculated. In each inertia category, when the sales of a single manufacturer was 2% or more of the total U.S. sales, one vehicle of the appropriate type was chosen to represent each 2% of the total sales. The remainder vehicles were chosen to represent unusual vehicles. Specifically, additional very heavy and very light vehicles were chosen. Also, vehicles with reputations of superior aerodynamic designs were added to the fleet, as were several vehicles with "boxy" poor looking aerodynamic designs. The vehicles were procured either by renting or by requesting participation from the automotive manufacturers; 63% were obtained from manufacturers and the remaining 37% were rented. Table 1 of Appendix A identifies and describes each vehicle.

A. The Track Measurements

The speed versus time data are the only measurements that are required on the test track. Ambient conditions were, however also monitored to allow correction to a set of standard ambient conditions.

1) Test Facility and Test Procedure

All vehicle speed versus time data were collected on the skid pad of the Transportation Research Center of Ohio, in East Liberty, Ohio. This facility is a multilane, concrete, straight track with large turn around loops at each end. Approximately 1 kilometer of this straight track has a constant grade of 0.5% and this section was used for all measurements.

Prior to the coast down measurements, the vehicle tires were adjusted, when cold, to the manufacturers recommended pressures. The cold tire pressures were recorded, as were the tire pressures immediately after the coast down tests. After adjustment of the tire pressures, the vehicles were warmed up for approximately 30 minutes at about 50 mph.

Twenty coast downs were recorded for each vehicle, ten in each direction of travel on the test track. Ten coast downs were conducted by accelerating the vehicle to approximately 65 mph, then shifting into neutral and recording speed versus time as the vehicle freely decelerated. The remaining ten coast downs were conducted in the same manner; however, the initial speed was approximately 40 mph. The two series of coast downs were necessary because the 1 km of section of track with constant grade was insufficient to coast most vehicles from 60 mph to a terminal speed near 10 mph.

2) Velocity Instrumentation

The vehicle speed was measured by a police type Doppler radar. The instrumentation contained a noise discriminator system which rejected the Doppler pulse count any time the period between pulses differed significantly from the previous pulse separation.

Modifications were made to the standard configuration to increase the range. The length of the antenna horn was increased and aluminum corner reflectors, or strips of aluminum foil, were placed inside the target vehicle windows. These modifications increased the range from about 0.5 km to approximately 1.0 km. The Doppler frequency counter gate time was also increased from approximately 30 msec to 300 msec in an attempt to improve the system precision. This modification did increase the speed resolution; however, it also increased the total period the discriminator evaluated the Doppler signal for extraneous noise. The system noise is basically random; therefore, the probability the discriminator will reject a measurement of the Doppler frequency is linear with the counter gate time. The increase in the precision of each measurement was accompanied by a decrease in the number of speed versus time points measured during the coast down. Also, the range was greatly reduced since the probability of radar signal noise increased as the distance from the transmitter to the target increased. This modification was subsequently rejected and the final configuration of the system provided a range of about 1 km with a resolution of ± 1 mph.

A count of the Doppler frequency was recorded each second during the coast downs on a seven track magnetic digital tape recorder. This recorder and the support electronics were placed in a small van, parked on the track berm. Electric power was provided by an alternator, battery bank, and inverter on this van. An example of the speed versus time record of a light duty vehicle coast down is given in Figure 1.

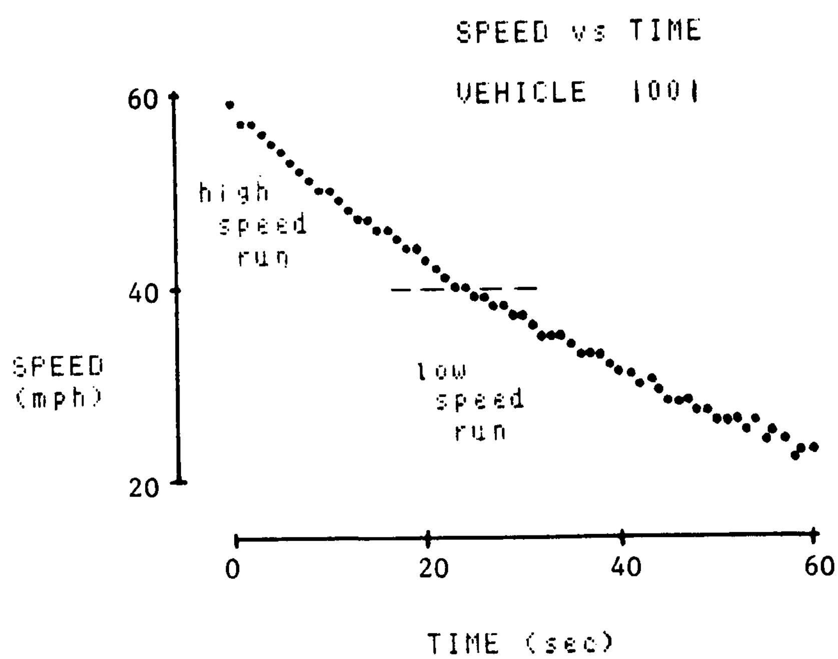


Figure 1

3) Ambient Conditions

Coastdowns were conducted only when steady winds were less than 15 km/hr (9.3 mph) with peak wind speeds less than 20 km/hr (12.4 mph). Wind speed during the test period was measured with a photochopper type six-cup anemometer. The anemometer was located near one side of the test track, at one end of the 1 km test section. These data were recorded at one second intervals on the same magnetic tape as was used to record the vehicle speed. During test periods the ambient temperature was in the range of 5°C (41°F) to 35°C (95°F). The barometric pressure was between 102 kPa (30.2 in Hg) and 94 kPa (27.9 in Hg). The air moisture content ranged from 0.29 to 0.73 gm H_2O/gm dry air. These slowly varying ambient parameters were recorded by an observer on a data sheet associated with each vehicle.

B. The Dynamometer Measurements

The dynamometer measurements are conceptually simple since the desired information is force data, and the dynamometer could be used to measure forces directly. The dynamometer used was one of the EPA light duty vehicle electric dynamometers. This dynamometer is a G.E. motor-generator type with a 48" diameter single roll. During these experiments the normal 0-1000 lb. load cell of the dynamometer was replaced with a more sensitive 0-300 lb load cell.

Prior to all measurements the cold tire pressures were adjusted to the manufacturers recommended pressures. Again, the cold pre-test pressures and the hot post-test pressures were recorded. The vehicle weight was adjusted to approximate the vehicle weight during the corresponding track measurement. The dynamometer force measurements were conducted on both the front and rear axles of the vehicle. During the rear axle measurements the transmission was shifted into neutral, as it was during the track coastdowns.

The vehicle was placed on the dynamometer, and then the vehicle and dynamometer were warmed up for 30 minutes at approximately 50 mph. After warm up, the torque necessary to motor the dynamometer and vehicle was measured at speeds from 60 to 10 mph in 5 mph decreasing speed intervals. For each measurement steady state dynamometer speed and torque signals were recorded on a strip chart for a period of approximately 100 seconds. The stabilized values were then read from the strip chart by the dynamometer operator.

After the measurements were completed with the full vehicle weight resting on the dynamometer rolls, the vehicle was then lifted until the vehicle tires were just contacting the dynamometer roll. The vehicle tires were considered to be just touching the dynamometer roll if a person could, with difficulty, manually cause the tire to slip on the roll when the roll was locked. With this test configuration the torque versus speed measurements were repeated as before. Finally, the torque required to motor only the dynamometer was recorded in the same manner.

The dynamometer speed data were converted to the units of m/sec. All torque data were converted to force in newtons at the roll tire interface. A scatter plot of the data from one vehicle, after conversion to force at the tire-roll interface and subtraction of the force necessary to motor the dynamometer, is given as an example in Figures 2(a) and 2(b). In addition, the difference between the force measurement when the full weight of the vehicle was on the dynamometer and the force measurement when the tire was just contacting the dyno roll, is also given in Figures 2(a) and 2(b).

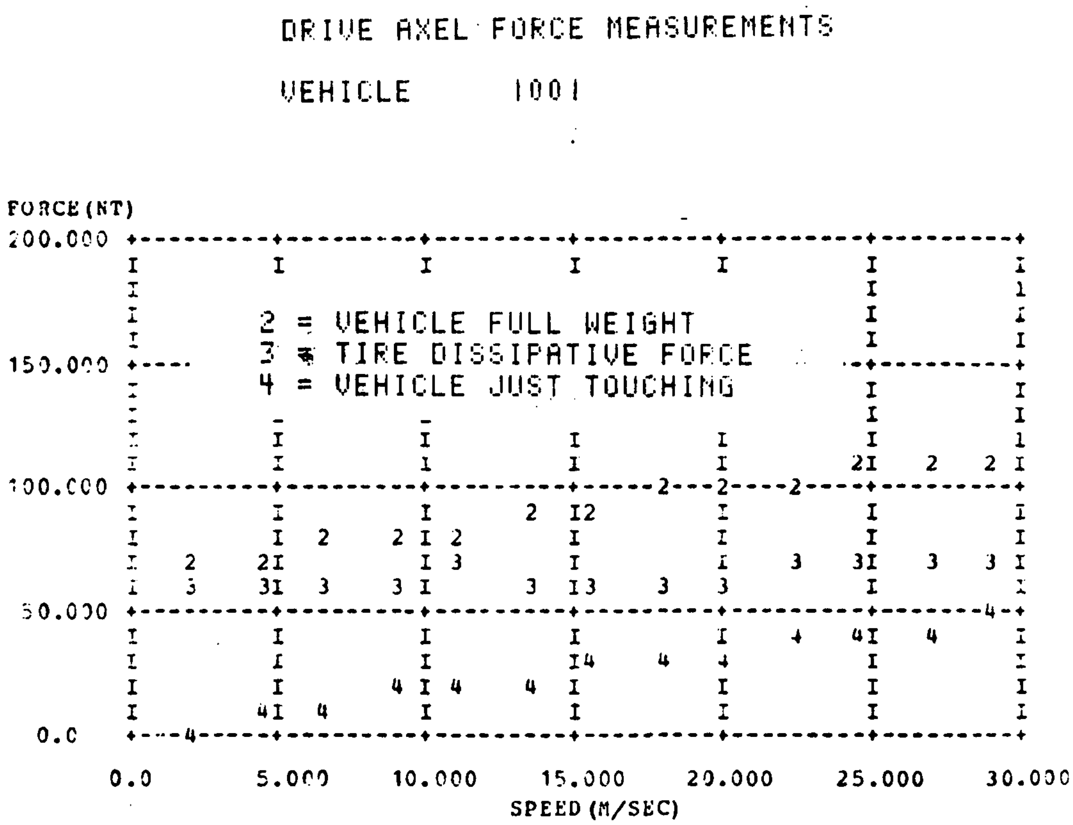


Figure 2 (a)

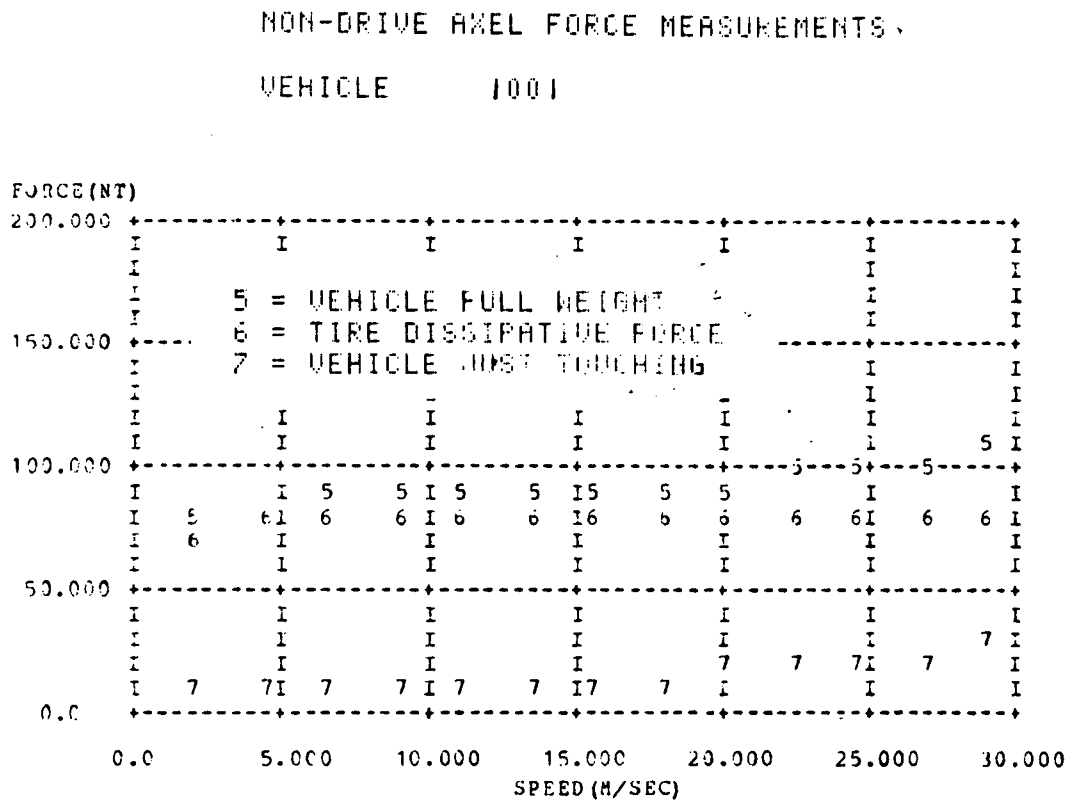


Figure 2 (b)

C. Masses

1) The Gravitational Masses

The gravitational mass was measured by weighing each vehicle, with the driver, immediately after the coast downs. The vehicle scale of the TRC was used for all vehicle mass determinations. TRC personnel indicated calibration checks on this scale have repeatedly been within ± 10 pounds in the 0 to 10,000 pound range.

2) Tire Mass

The tire mass was determined for each vehicle by weighing a tire, usually the spare tire, on a platform scale. This scale was a "shipping clerks" scale with a maximum capacity of 1000 lb, and a resolution of ± 0.5 lb.

V. Data Analysis

A. Track Data

The usual form of a vehicle deceleration curve is assumed to be a constant plus a term proportional to the velocity squared. However the effect of a steady head-tail wind will apear as a linear-term. Also, the drive train losses were expected to be approximately linear in velocity and some published tire data[5] have indicated the inclusion of a linear term may be theoretically desirable. For these reasons, a model equation was chosen of the form:

$$dv/dt = a_0 + a_1 v + a_2 v^2 \qquad (8)$$

Terms were added to equation (8) to account for any effects of wind and track grade. The variables of the resulting equation can be separated and integrated to yield an expression for time as a function of velocity. Since these functions are inverse trigonometric or hyperbolic functions, their inverse may be taken to yield velocity as a function of time. These functions were fitted to the coast down data by the method of least squares to determine the a_0, a_1, and a_2 of equation (8). The mathematics of this technique is discussed in detail in Reference 2 and in the EPA recommended practice for road load determination.

Since the a_2 coefficient multiplies the v^2 it was assumed to represent the aerodynamic drag of the vehicle. The aerodynamic drag is proportional to the air density; therefore all a_2 coefficients were corrected for differences between the ambient conditions during the test, and a set of standard ambient conditions chosen to be:

temperature	20°C (68°F)
barometric pressure	98 kPa (29.02 in Hg)
humidity	10 gm H_2O/kg dry air (70 gr H_2O dry air)

The corrected acceleration coefficients a_0, a_1, and a_2 of equation 8 are presented in table 1 of Appendix B for all vehicles tested. The vehicle tire pressures for the track measurements are give in table 2 of Appendix B.

B. Dynamometer Data

The dynamometer measurements determine the dissipative losses of the driving tires and the drive train. The dynamometer measurements are conceptually simple since the dynamometer used, a 48" roll GE electric chassis dynamometer, measures the forces directly. The only arithmetic necessary is to convert from the force values at the dynamometer load cell to the force at the tire-roll interface. This conversion is simply the ratio of the length of the moment arms. In addition a conversion to MKS units of force was made at this time.

The data for the tire dissipative losses, the wheel bearing losses, and the drive train dissipative losses were all scatterplotted versus speed. These plots indicate the wheel bearing and drive train losses are generally linear with speed, while the tire losses are approximately constant with speed. Consequently a linear least squares regression was fitted to each data set of the drive train and driving tire losses, the driving tire losses, the drive train losses and the non-driving tire losses. The coefficients from these regression analyses are given in Tables 1 through 4 respectively of Appendix C.

The vehicle tire pressures for the dynamometer measurements are given in Table 5 of Appendix C.

C. The total Effective Equivalent Mass of the Vehicle

The total effective mass of the vehicle is the sum of the gravitational mass and the equivalent effective masses of drive train, driving wheels, and non-driving wheels. These masses are given in Table 1 of Appendix D for each vehicle. The total vehicle effective mass is also given in this table.

VI. Results

The total vehicle road load is given by equation (4) as the product of the acceleration and the total system effective mass. The vehicle acceleration is known in the form of the acceleration coefficients of equation 8. Therefore, it is convenient to express the forces in terms of force coefficients where each force coefficient is the product of the total system effective mass and the corresponding acceleration coefficient. That is, for example, the force coefficient, f_0, is given by $f_0 = ma_0$. These force coefficients were calculated for all vehicles and are presented in Table 1 of Appendix E. Also presented in Table 1 of Appendix E is the total road load force and power at 50 mph.

The total vehicle road load force is the sum of the tire rolling resistances; the dissipative losses of the drive train, wheel bearings, and brake drag; and the aerodynamic drag of the vehicle.

$$F_{TOT} = f_{tire} + f_{mech} + f_{aero} \qquad (9)$$

where

F_{TOT} = the total vehicle road load force

f_{tire} = the sum of the tire rolling resistances

f_{mech} = the mechanical dissipative losses

f_{aero} = the aerodynamic drag

The total vehicle road load force includes the dissipation in the drive train from the rear wheel up to the point where the drive train is decoupled from the engine. When the vehicle is being tested on a dynamometer, the vehicle engine is required to overcome the drive train and driving tire losses prior to supplying power to the dynamometer. Consequently these losses should not be included in the dynamometer adjustment force. The drive train losses are independent of the choice of a dynamometer, however, the tire rolling resistance will depend on the type of dynamometer. Therefore, to develop the appropriate dynamometer adjustment force, tire losses for that particular dynamometer must be subtracted from the total road measurements, in addition to the drive train losses.

A. Force Coefficients for Road Simulation on a Small Twin Roll Dynamometer

In order to calculate a force appropriate for adjusting a small twin roll dynamometer two assumptions must be made about tire power dissipation on a small twin roll dynamometer.

Assumption 1: "Two on the rolls equals four on the road".

It is commonly stated that two tires dissipate as much energy on a small twin roll dynamometer as four tires dissipate on a flat surface. However, measurements on sufficiently large tire sample to prove or disprove this concept have not yet been reported in the literature. There is some theoretical basis for this statement[6], and one study[7] reported a bias ply tire dissipated very nearly twice as much power on a small twin roll dynamometer as it dissipated on a flat surface. This was observed at inflation pressures of both 25 and 45 psi.

Assumption 2: "Power dissipation on a large single roll is proportional to road power dissipation.

The assumption that tire power dissipation on a large single roll dynamometer is greater than, but proportional to, the power dissipation a flat surface is much better documented. The relationship between tire losses on a large single roll and a flat surface, when determined by torque or power consumption measurements, has been shown theoretically to be given by:

$$F_R = F_D / \sqrt{1 + \frac{r}{R}} \qquad (10)$$

where

F_R = the rolling resistance of the tire on a flat road surface

F_D = the rolling resistance of the tire on a cylindrical dynamometer surface

r = the rolling radius of the tire

R = the radius of the dynamometer roll

The relationship given by equation (10) has been empirically tested by an SAE round-robin tire test program[9]. In addition, the theoretical treatise used to develop equation (10) has also been used to predict the relationship between tire rolling resistances on a large single roll and on a flat surface when the measurements are obtained directly from spindle force transducers. This relationship has been experimentally tested and appears reasonably valid.[10]

The rolling radii of the tires were determined by measuring the hight of the loaded tire, from the contact patch to the top of the tread and dividing by two. Previous experiments at the EPA have shown this technique is a very good simple static measurement of the dynamic rolling radius. Five to ten tires of each tire size were measured and the average roling radius used for all tires of that size. These average rolling radii are given in Figure 3.

Rolling Radii versus Tire Size

Nominal Tire Size	Average Rolling Radii
13 inches	0.28 m
14 inches	0.31 m
15 inches	0.34 m

Figure 3

The rolling radii given in Figure 3 were inserted into equation (10). The correction factor, $\sqrt{1+r/R}$ ranged from 0.826 to 0.801. Since this value was very nearly constant the value 0.813 was used to convert the rolling resistance measurements for all front and rear tires to estimates of the tire rolling resistance on a flat road. In addition, since the tires of light duty vehicles are usually inflated to 45 psi when the vehicle is operated on a small twin roll dynamometer, a correction factor was applied to estimate the flat surface rolling resistance of the tires at 45 psi. The correction factors used were 0.73 for bias ply tires and 0.81 for radial ply tires. These correction factors were derived from the SAE round robin data[9]. These data are from numerous measurements by five different tire testing laboratories, however the test sample was only five tires from a single manufacturer. The estimates of the tire rolling resistances, at 45 psi inflation pressure, of both the driving and non-driving tires, were subtracted from the total road forces as required by assumption 1. In addition, the drive train losses were also subtracted. The resulting coefficients are given in Table 2 of Appendix E as are the force and horsepower at 50 mph.

A significant purpose of this study is to develop equations to predict the appropriate dynamometer power absorber setting as a function of some easily measured vehicle parameter. The ability to predict the small twin roll dynamometer power absorber setting at 50 mph as a function of vehicle weight will be discussed in the following sections.

A theoretically based model can be developed based on several logical assumptions. The first assumption is that, because of similarities in manufacturing technology, the density of light duty vehicles is approximately constant.[11] Stated as an equation, the assumption is:

$$M \sim V \quad (11)$$

where

M = the mass of the vehicle

V = the volume of the vehicle

The vehicle volume is approximately equal to the product of the three major dimensions. The second assumption is that each of the major vehicle dimensions may be expected to increase approximately equally with an increase in mass. Consequently each major dimension is proportional to the cube root of the vehicle mass. That is:

$$L \sim MW^{1/3} \quad (12)$$

where

L = any of the major vehicle dimensions of height width and length.

The twin roll dynamometer power absorber setting is primarily the aerodynamic drag of the vehicle. The aerodynamic drag is proportional to the frontal area which is approximately equal to the product of the vehicle height and width. Consequently the twin roll dynamometer force adjustment should be proportional to the mass of the vehicle to the two-thirds power.

$$F \sim M^{2/3} \quad (13)$$

The previous arguments are hardly rigorous, therefore a model of the form:

$$F = aM^{x} \quad (14)$$

was chosen which allowed the exponent to vary. This model will predict a dynamometer force setting of zero for a vehicle of zero mass, which is theoretically appropriate. Also, if x is less than 1, the model predicts the slope of the force versus mass curve will decrease as the mass increases. This is also theoretically logical; and consistent with the observed data.

The model, equation (14), unfortunately cannot be conveniently fitted to the data by least squares process. The fitting process is difficult since the normal equations resulting from the least squares criterion are non-linear. These equations can be solved simultaneously by numerical methods, however a simplier approach is to "linearize" equation (14) by the following logarithimic transformation.

$$\begin{aligned} \ln F &= \ln a M^{x} \\ &= \ln a + \ln M^{x} \\ &= \ln a + x \ln M \end{aligned} \qquad (15)$$

Identifying ln F as the dependent variable and ln M as the independent variable, equation (15) can now be fitted by a simple linear regression. The results of this regression are:

Regression of Twin Roll Dynamometer Force at 50 mph
versus
Vehicle Mass
Regression model $\ln F = \ln a + x \ln M$

$\ln F$ = the natural logarithm of the dynamometer force (nt) setting at 50 mph

$\ln M$ = the natural logarithm of the vehicle mass (kg)

$\ln a$ = 2.394

x = 0.479

Sample size 68

Converting to the form of the original model, the prediction equation is:

$$F = 11.0\, M^{0.479} \qquad (16)$$

The statistics of this regression cannot be readily interpreted since they are the statistics of the regression performed on the transformed parameters. In order to evaluate the prediction equation it is plotted, together with the data points, in figure 4. The fitted model is a reasonable appearing choice for these data. There is however a data scatter of approximately $\pm$ 50 nt about the fitted line.

Expressed in common U.S. engineering units equation (16) becomes:

$$Hp = 0.225\, W^{0.479} \qquad (17)$$

where:

Hp = the dynamometer power absorber setting at 50 mph (horsepower)

W = the vehicle weight (lb)

In this system of units the scatter of the data about the regression line is approximately $\pm$ 1.5 hp.

TWIN ROLL DYNAMOMETER FORCE ADJUSTEMENT AT 50 mph

VERSUS

VEHICLE MASS

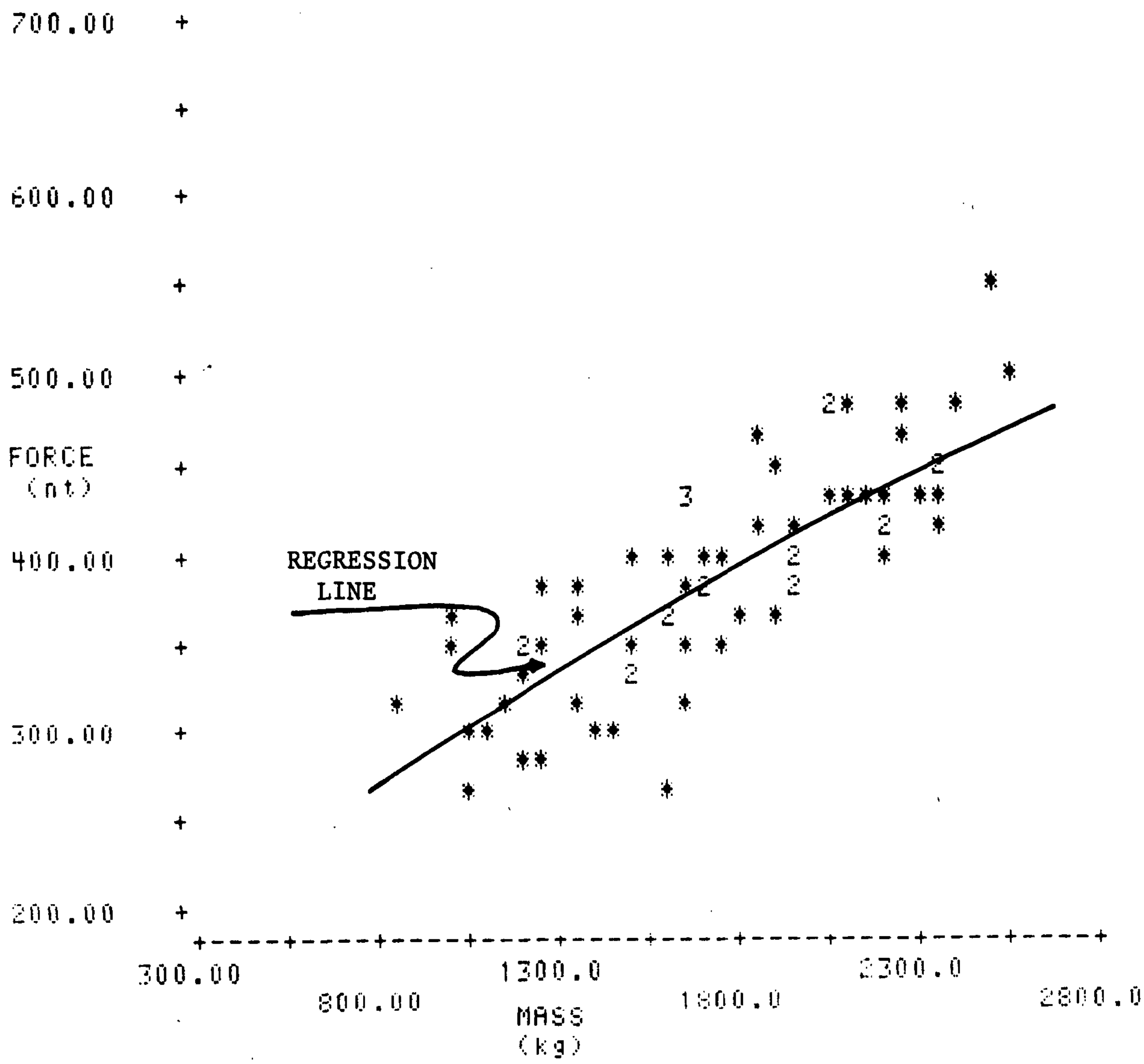


FIGURE 4

Equation (16) is probably appropriate only for vehicles fitted with tires of bias ply construction. Only one reference[7] discusses power dissipation of radial ply tires on a small twin roll dynamometer. This reference indicates radial ply tires, inflated to 45 psi, dissipate more than twice as much power as they would on a flat surface. The data presented would indicate two radial ply tires inflated to 45 psi, dissipate as much energy on a small twin roll dynamometer as four radial ply tires inflated to 25 psi would dissipate on a flat surface. If this is a more realistic treatment of radial ply tires, then the inflation pressure corrections should not be applied to the tire rolling resistance calculations for vehicles with radial tires.

In order to test the implied difference in appropriate dynamometer power absorber settings for vehicles with radial tires, a small twin roll dynamometer adjustment setting for vehicles with radial ply tires was calculated in the same manner as the previous calculation, except the tire pressure corrections were omitted. In this case coefficients representing the total estimated rolling resistance of all four tires at normal inflation pressures, were subtracted from the total road load measurements. The rusulting coefficients and the total force and power at 50 mph are given in Table 3 of Appendix E.

A regression of the form (15) was computed to develop a prediction of the dynamometer power absorber setting versus vehicle weight. The results of this regression are:

Regression of Twin Roll Dynamometer
Force at 50 mph for Vehicles
With Radial Ply Tires

Regression Model

$\ln F = \ln a + x \ln M$

$\ln F$ = the natural logarithm of the dynamometer force (nt) setting at 50 mph

$\ln M$ = the natural logarithm of the vehicle mass (kg)

$\ln a = 2.484$

$x = 0.456$

Sample Size 68

Converting to the form of the original model:

$$F = 12.0\ M^{0.456} \qquad (18)$$

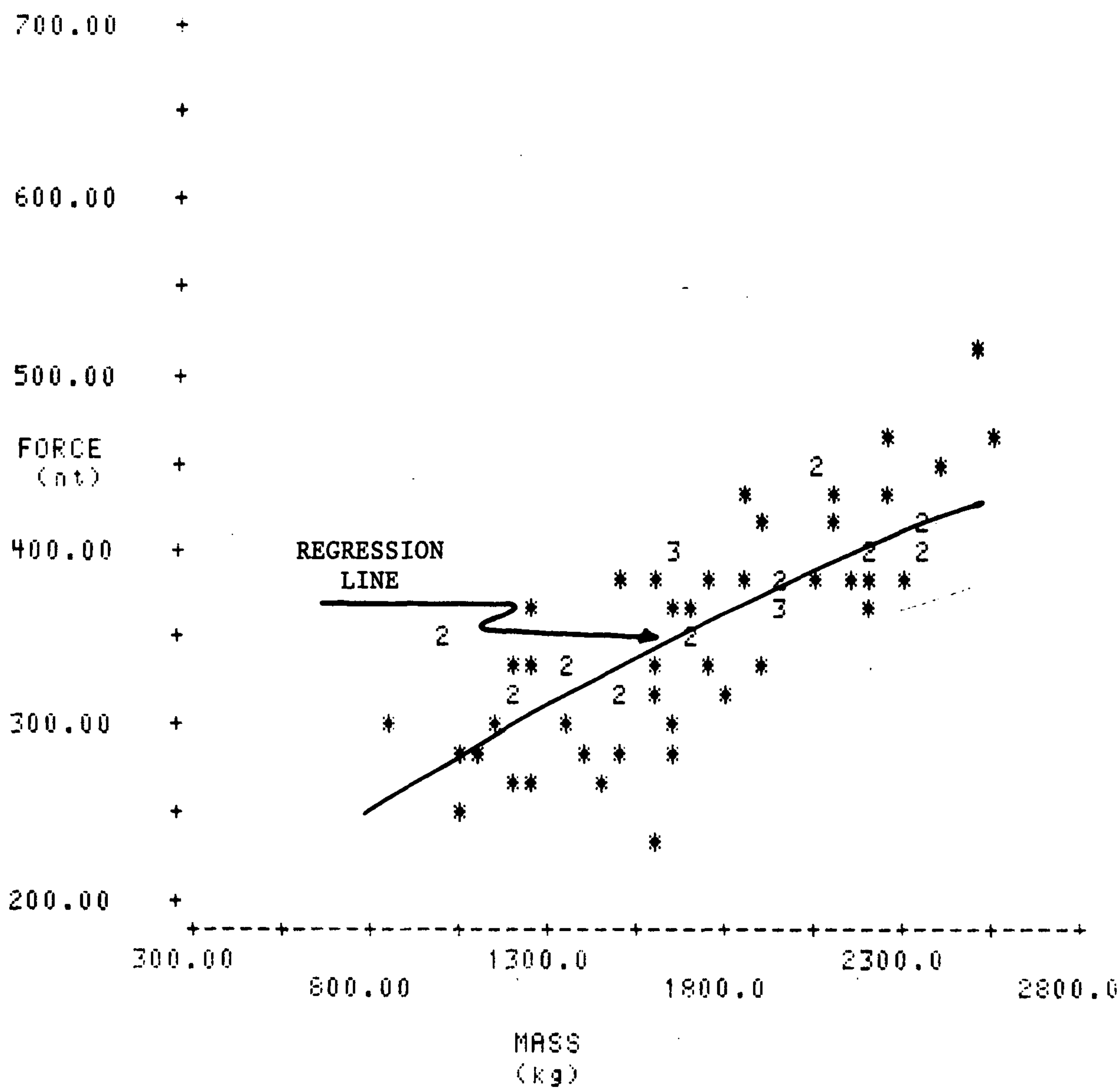
Equation (18) is plotted in Figure 5 together with the data used in the regression. Equation 18, expressed in common engineering units, is:

$$Hp = 0.251\ W^{0.456} \qquad (19)$$

ESTIMATES OF TWIN ROLL DYNAMOMETER
FORCE ADJUSTMENTS FOR VEHICLES WITH RADIAL TIRES

VERSUS

VEHICLE MASS



B. Large Roll Dynamometer Adjustment Force

Equations to predict the power absorber settings for large single roll dynamometer are developed since these equations may be useful at the present, or in future work.

The appropriate adjustment force for a large roll dynamometer can be obtained directly since the tire and drive train dissipative losses were measured on this dynamometer. To obtain the force coefficients appropriate for adjusting a 48" roll dynamometer, the coefficients of the tire and drive train losses, given in Table 1 of Appendix C, were subtracted from the total force coefficients, give in Table 1 of Appendix E. The resulting net force coefficients, representing the sum of the non-driving tire and wheel bearing losses plus the vehicle aerodynamic drag, are presented in Table 4 of Appendix E. The forces at 50 mph and the appropriate power setting for a large single roll dynamometer to simulate the vehicle road load at 50 mph are also presented in Table 4.

A regression of the large roll dynamometer power absorbers setting versus vehicle mass similar to the previous regressions, was conducted.

The results were:

Regression of Large Single Roll Dynamometer
Power at 50 mph versus
Vehicle Weight

Regression model $\ln F = \ln a + x \ln M$

$\ln F$ = the natural logarithm of the dynamometer force (nt) setting at 50 mph

$\ln M$ = the natural logarithm of the vehicle mass (kg)

$\ln a$ = 1.999

x = 0.544

Sample Size 68

Converting to the form of the original model, the prediction equation is:

$$F = 7.384\, M^{0.544} \qquad (20)$$

or;

$$Hp = 0.144\, W^{0.544} \qquad (21)$$

Conclusions

The two small twin roll regression lines, equations (17) and (19) are plotted for comparison in Figure 6. Also plotted in Figure 6 are the horsepower versus weight points of the current LDV road load table. It is apparent the first regression line agrees very well with the current table, while the second equation is approximately one horsepower lower.

Dynamometer Power Absorber Setting at 50 mph

vs.

Vehicle Weight

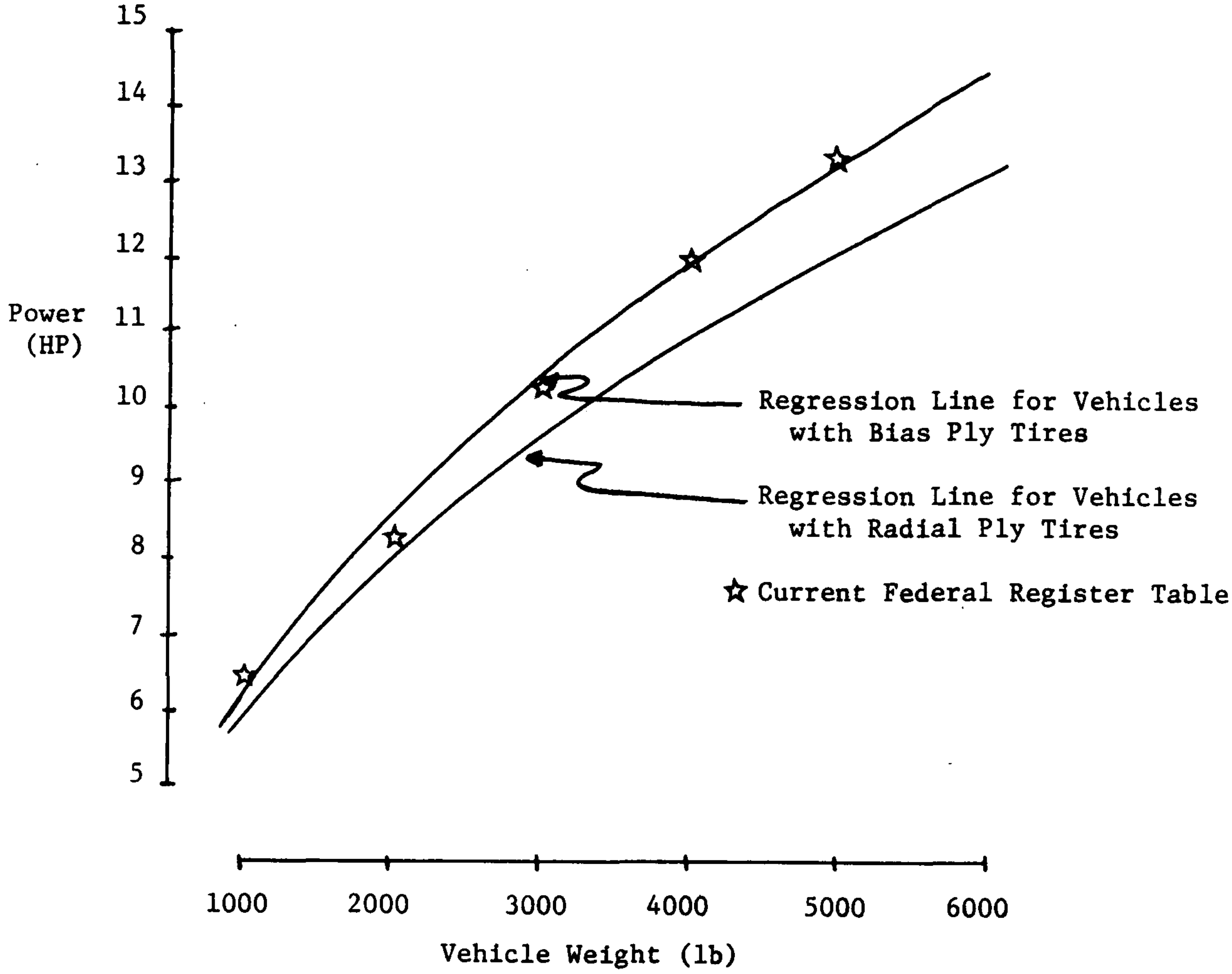


Figure 6

This indicates the current table is approximately correct for bias ply tires, but predicts higher than actual road load for vehicles with radial ply tires. The accuracy of second line is however, questionable since the tire-roll interaction assumptions used in computing this line have only been reported once in the literature. In addition, this reference only dicusses measurements on a single radial ply tire. At the present time this line should be considered as an indication of the magnitude of possible radial tire effects. A limited test program to investigate tire effects in greater detail is currently in progress by the SAE Committee on Tire Rolling Resistance. A more extensive program is also currently in progress by the EPA.

The amount of data scatter observed will not be reduced by any additional tire information. It is therefore concluded that any road load prediction system based on vehicle weight will have an accuracy of approximately ± 1.5 horsepower. Two of the vehicles in the test fleet, a Pontiac Lemans and a Ford Granada, were repeat tested. The variations in estimated twin roll dynamometer power absorber settings between the repeat tests were about 0.5 hp, or 4% of value in each instance. It can therefore be concluded that much of the ± 1.5 horsepower data scatter about the prediction line occurs because of the inadequacy of the regression model and is not simply random measurement error. Equation (9) followed by the corrections for tire rolling resistance demonstrate the aerodynamic forces predominate in the small twin roll dynamometer adjustment. Since there is little if any direct relationship between the vehicle weight and the aerodynamic forces on the vehicle, the vehicle weight is not a physically logical parameter to use to predict the dynamometer absorber power setting.

It is concluded that a system to predict the dynamometer power absorber setting based on the aerodynamic parameters of the vehicle should be investigated. Such a prediction system would be physically logical, and may be able to reduce the average error in predicting the dynamometer power absorber setting. Because of the theoretical advantages, a dynamometer power absorber setting prediction system based on vehicle aerodynamic parameters should be adopted. This is recommended even if it can only be shown that this would not result in a decrease in the accuracy of the prediction of the dynamometer power absorber setting compared with prediction systems based on vehicle weight.

Recommendations

It is recommended that the data from the tire studies currently in progress be incorporated into this analysis as soon as these data become available. Specifically, more information is necessary on the tire-roll interaction on small twin roll dynamometers. This information may indicate a correction factor based on the vehicle tire type should be introduced in road load prediction system.

It is also recommended that dynamometer adjustment prediction systems based on vehicle aerodynamic parameters be considered. This is the logical approach to improve the accuracy of the prediction of the dynamometer power absorber setting. This approach can also provide the incentive for improvements in the aerodynamic characteristics of vehicles.

No change in the current light duty vehicle road load table is recommended until one or both of the above improvements can be incorporated.

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9. S. Clark, unpublished report to the SAE Subcommittee on Tire Rolling Resistance.

10. D. J. Schuring, "Rolling Resistance of Tires Measured Under Transient and Equilibrium Conditions on Calspan's Tire Research Facility." DOT-TSC-OST 76-9, March 1976.

11. C.W. LaPoint, Suggestion during telephone conversation.

APPENDIX A

VEHICLE IDENTIFICATION

Table 1

Test Fleet

Vehicle Identification Number	Model Year	Manufacturer	Model Name	Body Style	Test Weight (lbs)
101	1974	Chevrolet	Impala	Sedan	4560
201	1975	Chevrolet	Chevelle	Sedan	4100
301	1975	Pontiac	Firebird	Sedan	3640
401	1975	Pontiac	Ventura	Sedan	3520
502	1975	Ford	Pinto	Sedan	2800
601	1975	Oldsmobile	Cutlass	Sedan	4250
804	1974	American Motors	Gremlin	Sedan	2970
901	1975	Chevrolet	Impala	Stationwagon	5250
1001	1975	Chevrolet	Vega	Sedan	2680
1102	1975	Ford	Granada	Sedan	3510
1201	1975	Buick	Century	Sedan	4140
1301	1975	Buick	Special	Sedan	4020
1401	1975	Buick	Skylark	Sedan	3720
1501	1975	Buick	Apollo	Sedan	3910
1601	1975	Chevrolet	Monza	Sedan	3490
1702	1975	Ford	Mustang	Sedan	3000
1802	1975	Ford	Mustang	Sedan	3020
1901	1975	Buick	Skyhawk	Sedan	3200
2102	1975	Mercury	Capri	Sedan	2570
2203	1975	Plymouth	Valiant	Sedan	3600
2301	1975	Buick	LeSabre	Sedan	4870
2401	1975	Buick	Estate	Stationwagon	5590
2502	1975	Lincoln	Continental	Sedan	5450
2602	1973	Mercury	Capri	Sedan	2350
2706	1975	Toyota	Corolla	Sedan	2470
2802	1975	Mercury	Comet	Sedan	3320
2906	1975	Toyota	Celica	Sedan	2760
3011	1975	Saab	99	Sedan	2710
3102	1975	Ford	Mustang	Sedan	3320
3212	1975	Triumph	TR6	Convertible	2650
3304	1975	American Motors	Pacer	Sedan	3330
3402	1975	Ford	Maverick	Sedan	3320
3505	1975	Volkswagon	Rabbit	Sedan	2170
3613	1975	Honda	CVCC	Sedan	1900
3712	1975	Triumph	TR6 (1)	Convertible	2630
3908	1975	Mazda	RX-3	Stationwagon	2680
4014	1975	Fiat	128	Sedan	2180
4102	1975	Mercury	Montego	Sedan	4560
4202	1975	Ford	Gran Torino	Sedan	4570
4302	1975	Mercury	Marquis	Sedan	4990
4402	1975	Ford	LTD	Sedan	4860
4507	1975	Datsun	280Z	Sedan	3110

(1) Same vehicle as 3212, however convertible top down.

Table 1 con't.

Vehicle Identification Number	Model Year	Manufacturer	Model Name		Body Style	Test Weight (lbs)
4607	1975	Datsun	B210		Sedan	2310
4701	1975	Pontiac	Lemans		Sedan	4230
4801	1975	Oldsmobile	Cutlass		Sedan	4330
4903	1975	Dodge	Dart		Sedan	3610
5001	1975	Pontiac	Lemans		Sedan	4260
5103	1975	Plymouth	Valiant		Sedan	3580
5203	1975	Plymouth	Gran Fury		Sedan	4840
5303	1975	Plymouth	Scamp		Sedan	3680
5403	1975	Plymouth	Valiant		Sedan	3620
5503	1975	Chrysler	New Yorker		Sedan	5120
5603	1975	Chrysler	Newport		Sedan	4840
5601	1975	Pontiac	Lemans	(2)	Sedan	4320
5701	1975	Oldsmobile	Delta 88		Sedan	4770
5802	1975	Ford	Granada		Sedan	3760
6002	1975	Mercury	Montego		Sedan	4500
6102	1975	Ford	LTD		Sedan	5020
6202	1975	Ford	Torino		Sedan	4420
6302	1975	Ford	Granada	(3)	Sedan	3800
6402	1975	Ford	LTD		Sedan	5060
6502	1975	Ford	Gran Torino		Stationwagon	5210
6702	1975	Ford	Gran Torino		Stationwagon	5000
6802	1975	Ford	Torino		Sedan	4600
6909	1976	Volvo	264DL		Sedan	3290
8101	1975	Chevrolet	Corvette		Sedan	3850
8401	1975	Oldsmobile	Toronado		Sedan	5170
9101	1975	Chevrolet	Corvette	(4)	Sedan	3820

(2) Same vehicle as 5001.

(3) Same vehicle as 5802.

(4) Same vehicle as 8101, however head lamps up.

APPENDIX B

TRACK MEASUREMENTS

TABLE 1
AMBIENT CORRECTED ACCELERATION COEFFICIENTS

ID	A0 (M/SEC**2)	A1 (1/SEC)	A2 (1/M)
101	0.1130E+00	0.1939E-02	0.2754E-03
201	0.1676E+00	-0.3935E-02	0.5192E-03
301	0.8516E-01	0.6844E-02	0.1176E-03
401	0.1649E+00	-0.1754E-02	0.4208E-03
502	0.1588E+00	-0.2409E-02	0.5492E-03
601	0.1612E+00	-0.4964E-02	0.4762E-03
804	0.7939E-01	0.1229E-01	0.7436E-04
901	0.8552E-01	0.2782E-02	0.2678E-03
1001	0.1504E+00	0.3904E-02	0.3246E-03
1102	0.8275E-01	0.6042E-02	0.2807E-03
1201	0.5664E-01	0.8590E-02	0.1690E-03
1301	0.6549E-01	0.6402E-02	0.2093E-03
1401	0.6375E-01	0.8297E-02	0.1297E-03
1501	0.1013E+00	0.5148E-02	0.1973E-03
1601	0.1252E+00	-0.7781E-03	0.3040E-03
1702	0.9745E-01	0.3794E-02	0.3116E-03
1802	0.1291E+00	0.3468E-02	0.3214E-03
1901	0.1323E+00	-0.1569E-02	0.3780E-03
2102	0.1287E+00	0.1502E-02	0.4313E-03
2203	0.1352E+00	-0.2185E-02	0.4445E-03
2301	0.8436E-01	0.3521E-02	0.2288E-03
2401	0.7363E-01	0.3121E-02	0.2537E-03
2502	0.1158E+00	0.1943E-02	0.1996E-03
2602	0.1114E+00	0.4465E-02	0.3056E-03
2706	0.8610E-01	0.5536E-02	0.3022E-03
2802	0.1144E+00	0.3007E-02	0.2962E-03
2906	0.1369E+00	-0.3672E-02	0.5008E-03
3011	0.1697E+00	-0.3998E-02	0.5474E-03
3102	0.1098E+00	0.4164E-02	0.2407E-03
3212	0.1992E+00	-0.7761E-02	0.6315E-03
3304	0.1124E+00	0.4277E-02	0.2420E-03
3402	0.6446E-01	0.9504E-02	0.1035E-03
3505	0.1418E+00	-0.3726E-03	0.5118E-03
3613	0.7354E-01	0.1132E-01	0.2389E-03
3712	0.1211E+00	0.6316E-02	0.2389E-03

TABLE 1 (CONTINUED)
AMBIENT CORRECTED ACCELERATION COEFFICIENTS

ID	A0 (M/SEC**2)	A1 (1/SEC)	A2 (1/M)
3908	0.1475E+00	0.4271E-03	0.4805E-03
4014	0.1524E+00	-0.2635E-02	0.6731E-03
4102	0.1153E+00	0.3280E-02	0.2288E-03
4202	0.7720E-01	0.9455E-02	0.8169E-04
4302	0.2830E+00	-0.1608E-01	0.7113E-03
4402	0.1176E+00	0.2571E-03	0.2944E-03
4507	0.8369E-01	0.6287E-02	0.1726E-03
4607	0.1181E+00	0.3643E-02	0.3109E-03
4701	0.1096E+00	0.1152E-03	0.3044E-03
4801	0.1081E+00	-0.2732E-03	0.3597E-03
4903	0.8181E-01	0.8049E-02	0.1011E-03
5001	0.1916E+00	-0.7778E-02	0.5147E-03
5103	0.9281E-01	0.8928E-02	0.1456E-03
5203	0.1083E+00	0.3008E-02	0.2144E-03
5303	0.1013E+00	0.7480E-02	0.1516E-03
5403	0.1679E+00	-0.2029E-02	0.4646E-03
5503	0.1401E+00	-0.1623E-02	0.3402E-03
5601	0.9781E-01	0.3522E-02	0.2115E-03
5603	0.6406E-01	0.7376E-02	0.1024E-03
5701	0.1024E+00	0.3463E-02	0.2136E-03
5802	0.9902E-01	0.4441E-02	0.2530E-03
6002	0.1183E+00	0.4866E-02	0.1800E-03
6102	0.6200E-01	0.7499E-02	0.8659E-04
6202	0.7899E-01	0.8668E-02	0.1223E-03
6302	0.1270E+00	-0.7405E-03	0.4087E-03
6402	0.6290E-01	0.6048E-02	0.1515E-03
6502	0.8449E-01	0.3702E-02	0.2284E-03
6702	0.8994E-01	0.2250E-02	0.3168E-03
6802	0.1381E+00	-0.3504E-02	0.4599E-03
6909	0.6893E-01	0.7823E-02	0.2174E-03
8101	0.1936E+00	-0.5090E-02	0.4243E-03
8401	0.1030E+00	0.2531E-02	0.2266E-03
9101	0.1292E+00	0.2700E-02	0.2673E-03

TABLE 2

TRACK AMBIENT CONDITIONS

VEHICLE ID	TEST DATE	DRY BULB TEMP (F)	WET BULB TEMP (F)	BAROMETRIC STATION PRESSURE (IN HG)	MEAN WIND SPEED (MPH)
101	7 15 75	70.0	63.0	29.00	5.1
201	7 15 75	75.0	64.0	28.98	6.8
301	7 17 75	72.0	66.0	29.00	0.0
401	7 17 75	77.0	68.0	29.00	5.3
502	7 17 75	81.0	70.0	28.98	7.1
601	7 22 75	85.0	71.0	28.80	5.9
804	7 22 75	92.0	71.5	28.84	3.8
901	7 22 75	88.0	69.5	28.84	4.0
1001	7 24 75	76.0	71.0	28.88	9.2
1102	7 25 75	72.0	63.0	28.78	4.8
1201	7 25 75	74.0	64.0	28.80	5.9
1301	7 25 75	75.5	64.5	28.79	4.8
1401	7 25 75	79.5	64.0	28.80	4.2
1501	7 25 75	86.0	64.5	28.81	7.5
1601	7 25 75	86.0	65.0	28.80	6.9
1702	7 29 75	73.0	65.0	28.85	2.4
1802	7 29 75	80.0	68.0	28.88	3.6
1901	7 29 75	84.0	68.0	28.96	4.6
2102	7 30 75	86.5	69.0	28.94	3.7
2203	7 30 75	91.0	68.0	28.94	3.9
2301	7 30 75	92.0	68.5	28.94	3.8
2401	7 30 75	95.0	70.0	28.91	2.8
2502	7 31 75	74.0	69.0	28.95	0.6
2602	8 1 75	82.0	74.0	28.96	0.0
2706	8 1 75	85.0	75.0	28.96	0.1
2802	8 1 75	90.0	76.0	29.94	2.1
2906	8 1 75	91.0	76.0	28.94	3.7
3011	8 5 75	76.0	69.5	28.74	1.6
3102	8 5 75	77.0	70.0	28.74	0.3
3212	8 5 75	81.5	71.0	28.74	3.3
3304	8 5 75	87.0	70.0	28.70	2.5
3402	8 7 75	65.7	59.0	28.91	5.8
3505	8 7 75	67.5	60.0	28.91	7.0
3613	8 7 75	68.5	60.0	28.92	8.3
3712	8 7 75	76.0	63.0	28.94	6.5
3908	8 26 75	87.5	71.5	28.85	7.9
4014	8 27 75	70.0	64.5	29.06	2.3
4102	8 27 75	75.5	66.0	29.10	3.5
4202	8 27 75	78.0	64.0	29.10	2.7

TABLE 2 (CONTINUED)

TRACK AMBIENT CONDITIONS

VEHICLE ID	TEST DATE	DRY BULB TEMP (F)	WET BULB TEMP (F)	BAROMETRIC STATION PRESSURE (IN HG)	MEAN WIND SPEED (MPH)
4302	8 27 75	83.0	64.5	29.08	3.1
4402	8 27 75	85.5	65.0	29.06	3.5
4507	8 27 75	85.5	65.0	29.05	2.6
4607	8 27 75	87.5	65.0	29.02	1.8
4701	8 27 75	88.0	65.5	29.04	2.1
4801	8 27 75	85.0	65.5	29.02	1.0
4903	8 28 75	70.8	63.0	29.02	3.7
5001	8 28 75	73.5	65.0	29.02	6.6
5103	8 28 75	79.0	65.5	29.02	5.9
5203	8 28 75	82.0	67.0	29.00	6.4
5303	8 28 75	87.0	67.5	28.98	4.8
5403	8 28 75	89.5	68.0	28.96	6.8
5503	8 28 75	89.0	67.5	28.94	7.4
5603	8 28 75	87.5	68.0	28.92	5.4
5601	8 29 75	76.5	69.0	28.80	8.0
5701	8 29 75	77.0	71.0	28.84	8.6
5802	8 29 75	77.5	71.0	28.82	9.3
6002	9 9 75	64.0	54.0	29.10	6.2
6102	9 9 75	67.0	51.0	29.10	5.4
6202	9 9 75	71.0	58.0	29.10	4.4
6302	9 9 75	73.0	57.0	29.10	3.0
6402	9 10 75	60.5	54.0	29.00	4.3
6502	9 10 75	75.0	66.0	28.99	7.4
6702	9 10 75	73.0	60.0	28.98	6.6
6802	9 10 75	79.0	64.0	28.94	5.8
6909	9 22 75	60.5	52.5	28.82	3.9
8101	10 23 75	75.0	59.0	28.84	4.7
8401	10 24 75	71.0	57.0	28.82	5.7
9101	10 16 75	52.0	46.0	28.92	3.2

TABLE 3

TRACK TIRE PRESSURES

VEHICLE ID	INITIAL PRESSURES FRONT (PSI)	REAR (PSI)	FINAL PRESSURES FRONT (PSI)		REAR (PSI)	
101	28.0	28.0	30.5	30.0	30.5	30.5
201	24.0	24.0	27.5	27.5	27.0	27.5
301	26.0	24.0	29.3	29.3	27.3	27.0
401	24.0	24.0	28.0	27.5	27.5	27.5
502	24.0	24.0	27.2	27.1	25.5	27.0
601	26.0	26.0	29.7	29.5	28.8	30.0
804	24.0	24.0	28.3	28.7	27.9	27.6
901	22.0	32.0	25.7	25.8	36.4	36.2
1001	24.0	26.0	28.0	28.0	28.0	28.0
1102	24.0	26.0	27.4	27.7	29.4	29.8
1201	26.0	26.0	29.5	29.2	30.0	29.7
1301	32.0	32.0	35.0	35.2	35.2	35.0
1401	24.0	24.0	27.5	27.4	27.7	27.4
1501	28.0	32.0	30.5	30.5	29.9	29.8
1601	30.0	32.0	33.8	33.2	35.4	33.8
1702	26.0	26.0	29.4	29.2	30.3	29.2
1802	26.0	26.0	29.8	29.5	30.0	30.0
1901	24.0	26.0	27.7	27.7	29.5	29.5
2102	27.0	31.0	27.3	27.0	34.9	34.7
2203	28.0	28.0	32.5	32.5	33.0	32.5
2301	26.0	28.0	29.5	29.5	31.7	31.0
2401	24.0	28.0	27.5	27.5	32.0	32.0
2502	26.0	26.0	29.7	29.6	30.0	30.0
2602	27.0	31.0	29.0	32.7	29.0	33.0
2706	24.0	24.0	26.0	26.0	26.5	26.0
2802	24.0	26.0	27.0	26.5	29.0	29.0
2906	24.0	24.0	27.0	26.5	28.0	27.5
3011	27.0	27.0	28.5	29.0	29.0	28.7
3102	26.0	26.0	28.5	28.0	28.0	29.0
3212	20.0	24.0	22.2	22.5	26.2	25.5
3304	26.0	24.0	28.3	28.2	28.0	27.5
3402	24.0	26.0	27.0	27.5	29.5	29.0
3505	27.0	27.0	29.2	28.5	28.5	28.5
3613	22.7	22.7	26.0	26.0	24.2	24.2
3712	20.0	24.0	21.2	22.0	26.0	26.2
3908	26.0	26.0	29.5	29.6	29.5	30.0
4014	26.0	24.0	28.5	28.5	26.5	26.5
4102	24.0	24.0	28.2	28.0	28.5	29.0
4202	24.0	24.0	28.5	28.2	29.5	28.8

TABLE 3 (CONTINUED)

TRACK TIRE PRESSURES

VEHICLE ID	INITIAL PRESSURES FRONT (PSI)	REAR (PSI)	FINAL PRESSURES FRONT (PSI)		REAR (PSI)	
4302	26.0	26.0	29.8	29.5	30.2	29.8
4402	26.0	26.0	30.0	29.2	29.5	29.5
4507	28.0	28.0	31.0	30.2	33.2	31.2
4607	24.0	24.0	28.0	27.0	27.8	26.5
4701	28.0	30.0	31.0	30.5	34.0	32.5
4801	28.0	28.0	30.8	30.5	30.8	30.5
4903	28.0	28.0	32.0	31.5	33.0	32.5
5001	28.0	30.0	32.0	33.5	33.5	32.0
5103	28.0	28.0	31.5	31.5	31.5	31.2
5203	26.0	26.0	29.5	30.0	30.5	29.2
5303	28.0	28.0	32.0	32.0	32.5	31.8
5403	28.0	28.0	32.0	32.0	32.0	31.5
5503	24.0	24.0	28.0	27.5	28.0	27.8
5603	26.0	26.0	29.0	28.5	29.5	29.0
5601	28.0	30.0	32.0	33.5	33.5	32.0
5701	26.0	28.0	29.8	29.8	31.5	31.5
5802	24.0	24.0	27.0	27.0	26.5	26.5
6002	24.0	24.0	27.0	26.0	27.2	27.0
6102	26.0	26.0	30.2	30.5	31.0	31.0
6202	24.0	26.0	27.8	27.0	28.5	29.0
6302	24.0	24.0	27.4	26.0	27.5	26.2
6402	26.0	26.0	29.5	29.8	30.0	29.8
6502	24.0	32.0	27.5	27.5	36.5	36.5
6702	24.0	32.0	27.0	27.0	36.5	36.0
6802	24.0	24.0	28.8	28.0	27.5	29.0
6909	25.0	26.0	26.5	27.0	28.2	29.0
8101	20.0	20.0	23.3	23.3	23.5	23.5
8401	28.0	24.0	30.5	30.5	25.4	25.0
9101	20.0	20.0	22.0	21.5	22.5	22.0

APPENDIX C

DYNAMOMETER MEASUREMENTS

TABLE 1
DRIVE TRAIN + DRIVING TIRE

REGRESSION COEFFICIENTS

ID	A (NT)	B (KG/SEC)
101	101.717	2.345
201	72.360	2.596
301	82.378	2.395
401	102.374	1.802
502	66.274	1.755
601	98.210	2.171
804	91.133	2.114
901	120.995	2.508
1001	80.064	2.143
1102	67.366	4.091
1201	95.005	3.026
1301	68.112	3.000
1401	69.966	2.529
1501	119.277	1.682
1601	67.916	2.077
1702	78.155	1.898
1802	101.203	1.175
1901	61.621	1.567
2102	60.839	2.102
2203	66.798	1.400
2301	127.981	1.518
2401	105.724	3.097
2502	43.744	1.852
2602	62.382	1.777
2706	50.067	1.482
2802	42.390	3.390
2906	57.992	1.886
3011	46.990	0.970
3102	93.368	1.118
3212	90.319	1.221
3304	101.832	2.452
3402	86.275	1.617
3505	28.401	0.631
3613	54.398	1.697
3712	90.319	1.221
3908	88.477	1.607
4014	32.686	0.923
4102	140.387	0.813
4202	127.891	1.554
4302	77.300	2.191
4402	102.101	2.117

TABLE 1 (CONTINUED)

DRIVE TRAIN + DRIVING TIRE

REGRESSION COEFFICIENTS

ID	A (NT)	B (KG/SEC)
4507	97.328	1.464
4607	63.221	1.541
4701	90.049	1.971
4801	107.353	1.803
4903	82.354	2.279
5001	59.980	3.248
5103	75.385	2.799
5203	81.945	3.205
5303	59.874	3.111
5403	80.495	2.372
5503	37.296	5.403
5601	59.980	3.248
5603	103.096	2.572
5701	115.754	1.660
5802	83.096	1.634
6002	121.589	1.244
6102	113.670	1.809
6202	86.157	4.361
6302	83.096	1.634
6402	134.417	1.544
6502	136.316	1.956
6702	108.470	2.888
6802	68.876	3.516
6909	68.550	1.798
8101	107.667	1.685
8401	198.481	0.215
9101	107.667	1.685

TABLE 2
DRIVING TIRE

REGRESSION COEFFICIENTS

ID	A (NT)	B (KG/SEC)
101	76.182	0.635
201	69.682	0.810
301	76.373	0.305
401	71.451	0.289
502	55.387	0.145
601	68.166	0.617
804	79.993	0.730
901	74.341	1.049
1001	76.744	0.276
1102	30.407	0.708
1201	98.372	-0.789
1301	46.631	0.676
1401	50.241	1.000
1501	86.593	-0.608
1601	39.212	0.637
1702	56.213	0.564
1802	73.240	0.297
1901	53.471	0.856
2102	46.485	0.580
2203	44.149	-0.633
2301	89.550	0.364
2401	88.606	0.995
2502	41.021	0.639
2602	37.919	0.138
2706	-6.761	1.540
2802	27.733	0.418
2906	47.383	0.436
3011	31.906	0.328
3102	69.702	0.139
3212	49.000	0.119
3304	79.946	0.798
3402	64.990	0.687
3505	18.437	0.167
3613	47.619	0.175
3712	49.000	0.119
3908	46.001	0.064
4014	26.975	0.324
4102	132.244	0.505
4202	85.202	0.868
4302	61.592	0.694
4402	68.730	0.506

TABLE 2 (CONTINUED)

DRIVING TIRE

REGRESSION COEFFICIENTS

ID	A (NT)	B (KG/SEC)
4507	62.980	0.269
4607	47.277	0.437
4701	67.365	0.672
4801	69.927	0.541
4903	66.040	0.570
5001	60.255	0.815
5103	58.705	0.575
5203	47.075	0.160
5303	40.020	1.540
5403	79.322	0.533
5503	56.476	0.768
5601	60.255	0.815
5603	66.405	0.658
5701	76.031	0.858
5802	64.147	0.342
6002	70.702	0.482
6102	87.241	0.589
6202	75.627	0.692
6302	64.147	0.342
6402	97.069	0.420
6502	69.242	0.583
6702	33.696	0.119
6802	53.527	0.768
6909	47.097	-0.018
8101	59.739	0.907
8401	70.915	-0.035
9101	59.739	0.907

TABLE 3
DRIVE TRAIN

REGRESSION COEFFICIENTS

ID	A (NT)	B (KG/SEC)
101	25.535	1.710
201	2.679	1.786
301	6.004	2.089
401	30.923	1.513
502	10.888	1.610
601	30.044	1.554
804	11.140	1.384
901	46.654	1.459
1001	3.318	1.867
1102	36.959	3.383
1201	-3.366	3.815
1301	21.482	2.324
1401	19.724	1.529
1501	32.683	2.291
1601	28.704	1.440
1702	21.942	1.334
1802	27.962	0.878
1901	8.148	0.711
2102	14.354	1.521
2203	22.649	2.033
2301	38.432	1.153
2401	17.118	2.102
2502	2.724	1.212
2602	24.463	1.640
2706	56.830	-0.058
2802	14.658	2.971
2906	10.609	1.450
3011	15.084	0.642
3102	23.667	0.979
3212	41.318	1.102
3304	21.886	1.655
3402	21.285	0.930
3505	9.963	0.464
3613	6.778	1.523
3712	41.318	1.102
3908	42.475	1.543
4014	5.712	0.599
4102	8.143	0.308
4202	42.689	0.686
4302	15.708	1.498
4402	33.372	1.611

TABLE 3 (CONTINUED)

DRIVE TRAIN

REGRESSION COEFFICIENTS

ID	A (NT)	B (KG/SEC)
4507	34.349	1.195
4607	15.943	1.104
4701	22.683	1.299
4801	37.426	1.261
4903	16.314	1.709
5001	-0.275	2.432
5103	16.679	2.224
5203	34.870	3.045
5303	19.853	1.570
5403	1.174	1.839
5503	-19.181	4.636
5601	-0.275	2.432
5603	36.690	1.913
5701	39.723	0.802
5802	18.948	1.293
6002	50.888	0.761
6102	26.430	1.220
6202	10.530	3.568
6302	18.948	1.293
6402	37.347	1.124
6502	67.073	1.373
6702	74.773	2.769
6802	15.348	2.749
6909	21.453	1.815
8101	47.929	0.778
8401	127.566	0.250
9101	47.929	0.778

TABLE 4
NON-DRIVING TIRE

REGRESSION COEFFICIENTS

ID	A (NT)	B (KG/SEC)
101	114.778	0.597
201	123.098	0.525
301	123.098	0.525
401	115.314	0.412
502	81.985	0.452
601	72.462	0.188
804	100.238	0.538
901	104.881	-0.011
1001	92.313	0.216
1102	50.929	0.923
1201	91.932	0.326
1301	93.828	0.235
1401	86.315	0.307
1501	123.098	0.525
1601	86.202	0.715
1702	69.056	0.560
1802	74.448	0.416
1901	82.243	0.583
2102	67.495	0.601
2203	21.178	1.949
2301	108.010	0.097
2401	86.186	1.013
2502	76.672	-0.123
2602	16.797	0.083
2706	57.807	0.550
2802	100.708	0.367
2906	35.769	0.520
3011	18.202	0.234
3102	92.667	0.377
3212	46.007	0.273
3304	100.238	0.538
3402	108.100	0.305
3505	16.797	0.083
3613	20.527	0.069
3712	46.007	0.273
3908	53.398	0.280
4014	39.645	0.062
4102	95.874	-0.696
4202	135.400	0.815
4302	124.442	0.230
4402	145.133	0.059

TABLE 4 (CONTINUED)

NON-DRIVING TIRE

REGRESSION COEFFICIENTS

ID	A (NT)	B (KG/SEC)
4507	59.390	-0.063
4607	62.766	0.139
4701	62.457	0.692
4801	86.218	0.348
4903	109.712	0.603
5001	80.086	0.415
5103	59.503	2.035
5203	122.697	-0.073
5303	92.273	0.402
5403	92.582	0.666
5503	119.843	0.985
5601	80.086	0.415
5603	103.466	0.883
5701	129.581	0.808
5802	101.203	0.597
6002	109.818	-0.190
6102	117.844	0.305
6202	153.439	0.196
6302	101.203	0.597
6402	124.460	0.548
6502	124.729	0.275
6702	77.671	0.170
6802	84.692	0.308
6909	62.098	0.386
8101	79.239	0.363
8401	81.411	0.560
9101	79.239	0.363

TABLE 5

DYNAMOMETER TEST CONDITIONS

VEHICLE ID	TEMP (F)	INITIAL TIRE PRESSURES FRONT (PSI)	INITIAL TIRE PRESSURES REAR (PSI)	FINAL TIRE PRESSURES FRONT (PSI)		FINAL TIRE PRESSURES REAR (PSI)	
101	73.0	28.0	28.0	32.3	31.9	31.4	31.9
201			24.0			25.5	25.5
301			24.0			24.0	26.0
401	75.0	24.0	24.0	28.7	27.9	27.0	27.0
502	73.0	22.0	22.0			26.0	24.0
601	74.0	26.0	26.0	31.1	30.5	28.5	28.0
804		24.0	24.0			27.8	28.4
901	76.0	22.0	32.0	25.7	25.7	35.8	36.0
1001	76.0					29.0	28.0
1102	73.0	24.0	26.0	28.0	28.0	26.5	26.0
1201	76.0	26.0	26.0	27.0	26.7	27.2	27.8
1301	78.0	32.0	32.0	34.8	35.4	35.0	35.0
1401	75.0	24.0	24.0	28.1	28.8	27.6	28.0
1501	76.0	26.0	26.0	30.4	30.3	28.0	28.0
1601	74.0	30.0	32.0	34.9	34.2	36.8	36.0
1702	74.0	26.0	26.0	29.0	29.5	29.5	29.5
1802	74.0	26.0	26.0	28.8	29.7	28.4	28.4
1901	78.0	24.0	26.0	27.2	28.2	28.5	28.5
2102	75.0	27.0	31.0	29.9	30.1	35.2	36.0
2203	76.0	28.0	28.0	30.0	30.8	31.4	31.2
2301	74.0	24.0	24.0	26.5	26.5	30.0	29.5
2401	75.0	24.0	28.0	27.6	28.0	33.9	34.1
2502	73.0	26.0	26.0	29.0	29.0	29.0	30.0
2602			31.0				
2706	76.0	24.0	24.0	26.0	26.0	25.5	26.0
2802	76.0	24.0	26.0	28.0	28.0	28.8	28.8
2906	75.0	24.0	24.0	25.7	25.8	25.3	25.7
3011	73.0	27.0	27.0	30.0	30.0	30.0	30.0
3102	75.0	26.0	26.0	29.2	29.2	28.8	28.8
3212	78.0	20.0	24.0	21.2	21.7	26.0	26.0
3304	74.0	26.0	24.0	30.6	30.9		
3402	74.0	24.0	26.0	28.4	28.8	29.8	30.4
3505	74.0						
3613	75.0	22.7	22.7	28.0	28.0	22.7	22.7
3712							
3908	76.0	26.0	26.0	30.6	31.2	29.8	29.8
4014		26.0	24.0	29.0	29.2	26.0	26.0
4102	74.0	24.0	24.0	26.2	25.8	27.5	27.5
4202	72.0	24.0	24.0	29.4	29.4	29.4	29.0

TABLE 5 (CONTINUED)

DYNAMOMETER TEST CONDITIONS

		INITIAL TIRE PRESSURES		FINAL TIRE PRESSURES			
VEHICLE ID	TEMP (F)	FRONT (PSI)	REAR (PSI)	FRONT (PSI)		REAR (PSI)	
4302	74.0	26.0	26.0	29.0	29.3		
4402	75.0	26.0	26.0	32.0	31.5	30.4	30.6
4507	74.0	28.0	28.0	32.3	32.3	33.3	33.8
4607	75.0	24.0	24.0	29.2	29.0	27.8	28.2
4701	76.0	26.0	24.0	30.4	30.7	29.4	28.9
4801	76.0	24.0	24.0	29.0	28.8	29.5	29.7
4903	73.0	28.0	28.0	33.6	33.0	31.6	31.0
5001							
5103	74.0	28.0	28.0	32.0	32.0	31.8	31.2
5203	75.0	26.0	26.0	29.2	29.0	29.4	29.8
5303	75.0	28.0	28.0	34.5	34.4	33.2	33.0
5403	76.0	28.0	30.0	33.3	33.0	33.8	34.0
5503	76.0	24.0	24.0	28.1	28.9	29.0	28.0
5603	75.0	26.0	26.0	31.4	31.0	29.5	30.1
5601	75.0	26.0	24.0	30.7	31.7	28.7	28.7
5701	74.0	26.0	25.0	32.1	32.1	30.0	31.2
5802	74.0	24.0	24.0	27.4	26.8	26.6	26.0
6002	73.0	24.0	24.0	28.0	27.2		
6102	74.0	24.0	26.0	30.3	30.6	32.0	31.0
6202	75.0	24.0	24.0	29.2	29.4	28.0	28.5
6302							
6402	75.0	26.0	26.0	30.4	30.8	27.0	27.2
6502	76.0	24.0	34.0	26.8	26.8	39.7	39.0
6702	76.0	24.0	32.0	25.6	25.5	35.0	35.5
6802	74.0	24.0	24.0	28.0	27.5	33.2	28.2
6909	76.0	25.0	26.0	27.8	27.8	28.0	28.2
8101	72.0	20.0	20.0	22.2	22.2	23.5	23.0
8401	73.0	26.0	20.0	30.5	31.6	21.0	21.5
9101	72.0	20.0	20.0	22.2	22.2	23.5	23.0

APPENDIX D

MASSES

TABLE 1
VEHICLE MASSES

ID	NDT EFF MASS (KG)	DTDT EFF MASS (KG)	GRAV MASS (KG)	TOTAL VEH MASS (KG)
101	23.14	32.16	2072.73	2128.03
201	21.10	28.91	1863.64	1913.65
301	20.86	25.67	1654.55	1701.08
401	21.22	24.82	1600.00	1646.05
502	17.75	19.75	1272.73	1310.22
601	23.98	29.97	1931.82	1985.77
804	17.03	20.95	1350.00	1387.97
901	27.34	37.02	2386.36	2450.73
1001	16.31	18.90	1218.18	1253.39
1102	22.06	24.75	1595.45	1642.27
1201	23.86	29.20	1881.82	1934.88
1301	24.46	28.35	1827.27	1880.08
1401	21.82	26.23	1690.91	1738.97
1501	17.99	27.57	1777.27	1822.83
1601	18.47	24.61	1586.36	1629.44
1702	18.59	21.16	1363.64	1403.38
1802	19.67	21.30	1372.73	1413.69
1901	16.67	22.57	1454.55	1493.78
2102	16.67	18.12	1168.18	1202.97
2203	20.50	25.39	1636.36	1682.26
2301	25.42	34.34	2213.64	2273.40
2401	27.34	39.42	2540.91	2607.67
2502	28.30	38.43	2477.27	2544.01
2602	16.67	16.57	1068.18	1101.42
2706	17.51	17.42	1122.73	1157.65
2802	21.34	23.41	1509.09	1553.85
2906	19.19	19.46	1254.55	1293.20
3011	17.51	19.11	1231.82	1268.44
3102	19.19	23.41	1509.09	1551.69
3212	22.06	18.69	1204.55	1245.30
3304	16.45	23.48	1513.64	1553.57
3402	21.22	24.68	1590.91	1636.82
3505	14.63	15.30	986.36	1016.30
3613	11.27	13.40	863.64	888.31
3712	22.06	18.69	1204.55	1245.30
3908	14.75	18.90	1218.18	1251.83
4014	12.71	15.37	990.91	1018.99
4102	24.94	32.16	2072.73	2129.83
4202	25.56	32.23	2077.27	2135.07
4302	28.06	35.19	2268.18	2331.43
4402	22.54	34.27	2209.09	2265.91

TABLE 1 (CONTINUED)
VEHICLE MASSES

ID	NDT EFF MASS (KG)	DTDT EFF MASS (KG)	GRAV MASS (KG)	TOTAL VEH MASS (KG)
4507	21.22	21.93	1413.64	1456.79
4607	13.91	16.29	1050.00	1080.20
4701	22.54	29.83	1922.73	1975.10
4801	23.50	30.54	1968.18	2022.22
4903	16.19	25.46	1640.91	1682.56
5001	23.98	30.47	1963.64	2018.08
5103	16.31	25.25	1627.27	1668.83
5203	26.14	34.13	2200.00	2260.27
5303	16.07	25.95	1672.73	1714.75
5403	17.89	25.53	1645.45	1688.87
5503	25.66	36.11	2327.27	2389.04
5601	23.98	30.47	1963.64	2018.08
5603	25.66	34.13	2200.00	2259.79
5701	22.18	33.64	2168.18	2224.00
5802	21.82	26.52	1709.09	1757.43
6002	24.22	31.74	2045.45	2101.41
6102	27.34	36.39	2345.45	2409.18
6202	24.22	30.18	1945.45	1999.86
6302	21.82	26.52	1709.09	1757.43
6402	28.78	35.68	2300.00	2364.46
6502	25.42	36.74	2368.18	2430.34
6702	23.50	35.26	2272.73	2331.49
6802	23.74	32.44	2090.91	2147.09
6909	17.03	23.20	1495.45	1535.68
8101	26.62	27.15	1750.00	1803.77
8401	28.30	36.46	2350.00	2414.76
9101	26.62	27.15	1750.00	1803.77

APPENDIX E

VEHICLE ROAD LOAD

AND

DYNAMOMETER ADJUSTMENT TO SIMULATE VEHICLE ROAD LOAD

TABLE 1
TOTAL VEHICLE ROAD LOAD

ID	GRAVMASS (KG)	F0 (NT)	F1 (KG/SEC)	F2 (KG/M)	F@50 (NT)	HP@50 (HP)
101	2072.7	0.2404E+03	0.4126E+01	0.5860E+00	0.6253E+03	18.742
201	1863.6	0.3208E+03	-0.7530E+01	0.9936E+00	0.6488E+03	19.446
301	1654.6	0.1449E+03	0.1164E+02	0.2000E+00	0.5050E+03	15.135
401	1600.0	0.2714E+03	-0.2887E+01	0.6926E+00	0.5528E+03	16.569
502	1272.7	0.2081E+03	-0.3156E+01	0.7195E+00	0.4970E+03	14.896
601	1931.8	0.3200E+03	-0.9857E+01	0.9457E+00	0.5721E+03	17.147
804	1350.0	0.1102E+03	0.1706E+02	0.1032E+00	0.5430E+03	16.275
901	2386.4	0.2096E+03	0.6818E+01	0.6562E+00	0.6898E+03	20.673
1001	1218.2	0.1885E+03	0.4893E+01	0.4068E+00	0.5011E+03	15.020
1102	1595.4	0.1359E+03	0.9923E+01	0.4610E+00	0.5880E+03	17.622
1201	1881.8	0.1096E+03	0.1662E+02	0.3270E+00	0.6444E+03	19.313
1301	1827.3	0.1231E+03	0.1204E+02	0.3936E+00	0.5887E+03	17.645
1401	1690.9	0.1109E+03	0.1443E+02	0.2255E+00	0.5460E+03	16.364
1501	1777.3	0.1847E+03	0.9384E+01	0.3596E+00	0.5741E+03	17.207
1601	1586.4	0.2040E+03	-0.1268E+01	0.4953E+00	0.4231E+03	12.680
1702	1363.6	0.1368E+03	0.5324E+01	0.4373E+00	0.4742E+03	14.213
1802	1372.7	0.1826E+03	0.4903E+01	0.4544E+00	0.5191E+03	15.560
1901	1454.6	0.1976E+03	-0.2344E+01	0.5647E+00	0.4273E+03	12.807
2102	1168.2	0.1549E+03	0.1807E+01	0.5188E+00	0.4544E+03	13.620
2203	1636.4	0.2275E+03	-0.3676E+01	0.7477E+00	0.5188E+03	15.551
2301	2213.6	0.1918E+03	0.8005E+01	0.5202E+00	0.6306E+03	18.899
2401	2540.9	0.1920E+03	0.8139E+01	0.6615E+00	0.7043E+03	21.110
2502	2477.3	0.2947E+03	0.4943E+01	0.5077E+00	0.6588E+03	19.744
2602	1068.2	0.1227E+03	0.4918E+01	0.3366E+00	0.4007E+03	12.011
2706	1122.7	0.9967E+02	0.6409E+01	0.3499E+00	0.4177E+03	12.518
2802	1509.1	0.1778E+03	0.4672E+01	0.4602E+00	0.5121E+03	15.348
2906	1254.6	0.1771E+03	-0.4749E+01	0.6477E+00	0.3945E+03	11.823
3011	1231.8	0.2152E+03	-0.5071E+01	0.6943E+00	0.4487E+03	13.449
3102	1509.1	0.1704E+03	0.6461E+01	0.3735E+00	0.5014E+03	15.028
3212	1204.6	0.2481E+03	-0.9665E+01	0.7864E+00	0.4249E+03	12.734
3304	1513.6	0.1747E+03	0.6645E+01	0.3760E+00	0.5110E+03	15.316
3402	1590.9	0.1055E+03	0.1556E+02	0.1693E+00	0.5378E+03	16.118
3505	986.4	0.1441E+03	-0.3787E+00	0.5202E+00	0.3955E+03	11.853
3613	863.6	0.6532E+02	0.1006E+02	0.2122E+00	0.3961E+03	11.871
3712	1204.6	0.1508E+03	0.7865E+01	0.2975E+00	0.4752E+03	14.243
3908	1218.2	0.1847E+03	0.5347E+00	0.6015E+00	0.4971E+03	14.899
4014	990.9	0.1553E+03	-0.2685E+01	0.6859E+00	0.4379E+03	13.126
4102	2072.7	0.2456E+03	0.6986E+01	0.4874E+00	0.6452E+03	19.339
4202	2077.3	0.1648E+03	0.2019E+02	0.1744E+00	0.7031E+03	21.074
4302	2268.2	0.6598E+03	-0.3749E+02	0.1658E+01	0.6504E+03	19.493
4402	2209.1	0.2665E+03	0.5826E+00	0.6670E+00	0.6127E+03	18.365

TABLE 1 (CONTINUED)
TOTAL VEHICLE ROAD LOAD

ID	GRAVMASS (KG)	F0 (NT)	F1 (KG/SEC)	F2 (KG/M)	F@50 (NT)	HP@50 (HP)
4507	1413.6	0.1219E+03	0.9159E+01	0.2515E+00	0.4522E+03	13.554
4607	1050.0	0.1275E+03	0.3935E+01	0.3359E+00	0.3833E+03	11.487
4701	1922.7	0.2164E+03	0.2275E+00	0.6013E+00	0.5219E+03	15.641
4801	1968.2	0.2186E+03	-0.5525E+00	0.7274E+00	0.5696E+03	17.072
4903	1640.9	0.1376E+03	0.1354E+02	0.1701E+00	0.5253E+03	15.745
5001	1963.6	0.3866E+03	-0.1570E+02	0.1039E+01	0.5546E+03	16.623
5103	1627.3	0.1549E+03	0.1490E+02	0.2431E+00	0.6093E+03	18.262
5203	2200.0	0.2448E+03	0.6799E+01	0.4845E+00	0.6388E+03	19.146
5303	1672.7	0.1736E+03	0.1283E+02	0.2600E+00	0.5902E+03	17.689
5403	1645.4	0.2835E+03	-0.3427E+01	0.7847E+00	0.5989E+03	17.949
5503	2327.3	0.3347E+03	-0.3877E+01	0.8128E+00	0.6541E+03	19.604
5601	1963.6	0.1974E+03	0.7108E+01	0.4269E+00	0.5695E+03	17.068
5603	2200.0	0.1448E+03	0.1667E+02	0.2314E+00	0.6329E+03	18.969
5701	2168.2	0.2278E+03	0.7702E+01	0.4750E+00	0.6372E+03	19.097
5802	1709.1	0.1740E+03	0.7805E+01	0.4446E+00	0.5706E+03	17.101
6002	2045.4	0.2486E+03	0.1023E+02	0.3783E+00	0.6661E+03	19.963
6102	2345.4	0.1494E+03	0.1807E+02	0.2086E+00	0.6574E+03	19.703
6202	1945.4	0.1580E+03	0.1733E+02	0.2446E+00	0.6676E+03	20.009
6[illegible]02	1709.1	0.2231E+03	-0.1301E+01	0.7182E+00	0.5528E+03	16.569
6402	2300.0	0.1487E+03	0.1430E+02	0.3583E+00	0.6473E+03	19.401
6502	2368.2	0.2053E+03	0.8997E+01	0.5551E+00	0.6837E+03	20.492
6702	2272.7	0.2097E+03	0.5246E+01	0.7385E+00	0.6958E+03	20.856
6802	2090.9	0.2965E+03	-0.7523E+01	0.9875E+00	0.6216E+03	18.631
6909	1495.4	0.1059E+03	0.1201E+02	0.3338E+00	0.5411E+03	16.218
8101	1750.0	0.3492E+03	-0.9181E+01	0.7654E+00	0.5263E+03	15.774
8401	2350.0	0.2487E+03	0.6112E+01	0.5472E+00	0.6586E+03	19.741
9101	1750.0	0.2331E+03	0.4870E+01	0.4822E+00	0.5828E+03	17.468

TABLE 2
TWIN SMALL ROLL DYNAMOMETER ESTIMATES

ID	GRAVMASS (KG)	F0 (NT)	F1 (KG/SEC)	F2 (KG/M)	F@50 (NT)	HP@50 (HP)
101	2072.7	0.1015E+03	0.1685E+01	0.5860E+00	0.4319E+03	12.945
201	1863.6	0.2037E+03	-0.1011E+02	0.9936E+00	0.4741E+03	14.211
301	1654.6	0.2052E+02	0.9058E+01	0.2000E+00	0.3229E+03	9.677
401	1600.0	0.1296E+03	-0.4815E+01	0.6926E+00	0.3680E+03	11.030
502	1272.7	0.1071E+03	-0.5158E+01	0.7195E+00	0.3513E+03	10.528
601	1931.8	0.1978E+03	-0.1194E+02	0.9457E+00	0.4033E+03	12.088
804	1350.0	-0.7893E+01	0.1492E+02	0.1032E+00	0.3772E+03	11.305
901	2386.4	0.5659E+02	0.4743E+01	0.6562E+00	0.4904E+03	14.698
1001	1218.2	0.8486E+02	0.2733E+01	0.4068E+00	0.3491E+03	10.465
1102	1595.4	0.4561E+02	0.5472E+01	0.4610E+00	0.3982E+03	11.935
1201	1881.8	-0.1181E+02	0.1311E+02	0.3270E+00	0.4445E+03	13.323
1301	1827.3	0.9527E+01	0.9118E+01	0.3936E+00	0.4099E+03	12.286
1401	1690.9	0.1644E+01	0.1204E+02	0.2255E+00	0.3835E+03	11.493
1501	1777.3	0.2758E+02	0.7142E+01	0.3596E+00	0.3668E+03	10.995
1601	1586.4	0.9307E+02	-0.3595E+01	0.4953E+00	0.2601E+03	7.797
1702	1363.6	0.3273E+02	0.3253E+01	0.4373E+00	0.3239E+03	9.707
1802	1372.7	0.5781E+02	0.3557E+01	0.4544E+00	0.3643E+03	10.918
1901	1454.6	0.1005E+03	-0.3998E+01	0.5647E+00	0.2932E+03	8.788
2102	1168.2	0.6581E+02	-0.4870E+00	0.5188E+00	0.3141E+03	9.414
2203	1636.4	0.1620E+03	-0.6571E+01	0.7477E+00	0.3886E+03	11.649
2301	2213.6	0.2384E+02	0.6549E+01	0.5202E+00	0.4301E+03	12.890
2401	2540.9	0.6028E+02	0.4722E+01	0.6615E+00	0.4963E+03	14.874
2502	2477.3	0.2148E+03	0.3391E+01	0.5077E+00	0.5442E+03	16.311
2602	1068.2	0.6236E+02	0.3134E+01	0.3366E+00	0.3005E+03	9.008
2706	1122.7	0.9372E+01	0.5096E+01	0.3499E+00	0.2981E+03	8.933
2802	1509.1	0.7893E+02	0.1186E+01	0.4602E+00	0.3353E+03	10.050
2906	1254.6	0.1120E+03	-0.6826E+01	0.6477E+00	0.2830E+03	8.481
3011	1231.8	0.1673E+03	-0.6081E+01	0.6943E+00	0.3782E+03	11.334
3102	1509.1	0.4028E+02	0.5142E+01	0.3735E+00	0.3418E+03	10.244
3212	1204.6	0.1445E+03	-0.1102E+02	0.7864E+00	0.2910E+03	8.720
3304	1513.6	0.4589E+02	0.4198E+01	0.3760E+00	0.3275E+03	9.817
3402	1590.9	-0.2927E+02	0.1398E+02	0.1693E+00	0.3677E+03	11.021
3505	986.4	0.1110E+03	-0.1008E+01	0.5202E+00	0.3484E+03	10.441
3613	863.6	0.1810E+02	0.8392E+01	0.2122E+00	0.3117E+03	9.341
3712	1204.6	0.4719E+02	0.6507E+01	0.2975E+00	0.3412E+03	10.227
3908	1218.2	0.7705E+02	-0.1233E+01	0.6015E+00	0.3500E+03	10.489
4014	990.9	0.1059E+03	-0.3536E+01	0.6859E+00	0.3695E+03	11.075
4102	2072.7	0.8789E+02	0.6804E+01	0.4874E+00	0.4834E+03	14.489
4202	2077.3	-0.2253E+02	0.1840E+02	0.1744E+00	0.4759E+03	14.263
4302	2268.2	0.5221E+03	-0.3959E+02	0.1658E+01	0.4654E+03	13.950
4402	2209.1	0.9291E+02	-0.1397E+01	0.6670E+00	0.3949E+03	11.835

TABLE 2 (CONTINUED)
TWIN SMALL ROLL DYNAMOMETER ESTIMATES

ID	GRAVMASS (KG)	F0 (NT)	F1 (KG/SEC)	F2 (KG/M)	F@50 (NT)	HP@50 (HP)
4507	1413.6	0.7320E+01	0.7829E+01	0.2515E+00	0.3079E+03	9.229
4607	1050.0	0.4625E+02	0.2488E+01	0.3359E+00	0.2697E+03	8.082
4701	1922.7	0.1086E+03	-0.1966E+01	0.6013E+00	0.3650E+03	10.940
4801	1968.2	0.7880E+02	-0.2395E+01	0.7274E+00	0.3886E+03	11.647
4903	1640.9	0.1699E+02	0.1114E+02	0.1701E+00	0.3508E+03	10.515
5001	1963.6	0.2949E+03	-0.1894E+02	0.1039E+01	0.3906E+03	11.707
5103	1627.3	0.6807E+02	0.1113E+02	0.2431E+00	0.4382E+03	13.133
5203	2200.0	0.9862E+02	0.3697E+01	0.4845E+00	0.4233E+03	12.686
5303	1672.7	0.7524E+02	0.1011E+02	0.2600E+00	0.4310E+03	12.918
5403	1645.4	0.1803E+03	-0.5978E+01	0.7847E+00	0.4387E+03	13.148
5503	2327.3	0.2383E+03	-0.9662E+01	0.8128E+00	0.4283E+03	12.838
5601	1963.6	0.1057E+03	0.3870E+01	0.4269E+00	0.4054E+03	12.151
5603	2200.0	-0.3265E+01	0.1374E+02	0.2314E+00	0.4195E+03	12.574
5701	2168.2	0.6606E+02	0.5913E+01	0.4750E+00	0.4355E+03	13.052
5802	1709.1	0.4664E+02	0.5897E+01	0.4446E+00	0.4005E+03	12.004
6002	2045.4	0.7936E+02	0.9278E+01	0.3783E+00	0.4757E+03	14.257
6102	2345.4	-0.1149E+02	0.1626E+02	0.2086E+00	0.4562E+03	13.674
6202	1945.4	-0.2716E+01	0.1308E+02	0.2446E+00	0.4118E+03	12.342
6302	1709.1	0.9574E+02	-0.3209E+01	0.7182E+00	0.3828E+03	11.472
6402	2300.0	-0.3389E+02	0.1254E+02	0.3583E+00	0.4254E+03	12.749
6502	2368.2	0.1105E+02	0.7061E+01	0.5551E+00	0.4461E+03	13.372
6702	2272.7	0.6191E+02	0.2287E+01	0.7385E+00	0.4819E+03	14.444
6802	2090.9	0.1905E+03	-0.1098E+02	0.9875E+00	0.4385E+03	13.142
6909	1495.4	0.1285E+02	0.9953E+01	0.3338E+00	0.4020E+03	12.050
8101	1750.0	0.2102E+03	-0.1079E+02	0.7654E+00	0.3513E+03	10.530
8401	2350.0	0.2126E+02	0.5518E+01	0.5472E+00	0.4179E+03	12.526
9101	1750.0	0.9405E+02	0.3261E+01	0.4822E+00	0.4078E+03	12.223

TABLE 3
TWIN SMALL ROLL DYNAMOMETER ESTIMATIONS
FOR VEHICLES WITH RADIAL TIRES

ID	GRAVMASS (KG)	F0 (NT)	F1 (KG/SEC)	F2 (KG/M)	F@50 (NT)	HP@50 (HP)
101	2072.7	0.5961E+02	0.1414E+01	0.5860E+00	0.3839E+03	11.507
201	1863.6	0.1614E+03	-0.1040E+02	0.9936E+00	0.4253E+03	12.746
301	1654.6	-0.2327E+02	0.8876E+01	0.2000E+00	0.2750E+03	8.243
401	1600.0	0.8863E+02	-0.4969E+01	0.6926E+00	0.3235E+03	9.697
502	1272.7	0.8553E+02	-0.5252E+01	0.7195E+00	0.3276E+03	9.817
601	1931.8	0.1756E+03	-0.1207E+02	0.9457E+00	0.3783E+03	11.340
804	1350.0	-0.4747E+02	0.1464E+02	0.1032E+00	0.3314E+03	9.933
901	2386.4	0.1724E+02	0.4515E+01	0.6562E+00	0.4459E+03	13.365
1001	1218.2	0.4774E+02	0.2625E+01	0.4068E+00	0.3096E+03	9.280
1102	1595.4	0.3281E+02	0.5216E+01	0.4610E+00	0.3797E+03	11.379
1201	1881.8	-0.4175E+02	0.1318E+02	0.3270E+00	0.4162E+03	12.475
1301	1827.3	-0.1257E+02	0.8975E+01	0.3936E+00	0.3846E+03	11.528
1401	1690.9	-0.1984E+02	0.1184E+02	0.2255E+00	0.3574E+03	10.711
1501	1777.3	-0.1846E+02	0.7160E+01	0.3596E+00	0.3212E+03	9.627
1601	1586.4	0.7333E+02	-0.3808E+01	0.4953E+00	0.2356E+03	7.062
1702	1363.6	0.1301E+02	0.3076E+01	0.4373E+00	0.3002E+03	8.998
1802	1372.7	0.3457E+02	0.3445E+01	0.4544E+00	0.3385E+03	10.147
1901	1454.6	0.7912E+02	-0.4224E+01	0.5647E+00	0.2668E+03	7.996
2102	1168.2	0.4788E+02	-0.6730E+00	0.5188E+00	0.2920E+03	8.751
2203	1636.4	0.1517E+03	-0.6778E+01	0.7477E+00	0.3737E+03	11.202
2301	2213.6	-0.7248E+01	0.6477E+01	0.5202E+00	0.3974E+03	11.910
2401	2540.9	0.3278E+02	0.4406E+01	0.6615E+00	0.4617E+03	13.838
2502	2477.3	0.1963E+03	0.3310E+01	0.5077E+00	0.5239E+03	15.702
2602	1068.2	0.5375E+02	0.3099E+01	0.3366E+00	0.2912E+03	8.726
2706	1122.7	0.1340E+01	0.4767E+01	0.3499E+00	0.2827E+03	8.472
2802	1509.1	0.5872E+02	0.1062E+01	0.4602E+00	0.3123E+03	9.361
2906	1254.6	0.9889E+02	-0.6976E+01	0.6477E+00	0.2665E+03	7.988
3011	1231.8	0.1594E+03	-0.6169E+01	0.6943E+00	0.3683E+03	11.039
3102	1509.1	0.1473E+02	0.5061E+01	0.3735E+00	0.3144E+03	9.424
3212	1204.6	0.1295E+03	-0.1108E+02	0.7864E+00	0.2746E+03	8.231
3304	1513.6	0.6325E+01	0.3905E+01	0.3760E+00	0.2814E+03	8.435
3402	1590.9	-0.5651E+02	0.1382E+02	0.1693E+00	0.3370E+03	10.100
3505	986.4	0.1055E+03	-0.1047E+01	0.5202E+00	0.3419E+03	10.249
3613	863.6	0.3142E+01	0.6338E+01	0.2122E+00	0.2955E+03	8.857
3712	1204.6	0.3224E+02	0.6445E+01	0.2975E+00	0.3249E+03	9.738
3908	1218.2	0.6141E+02	-0.1287E+01	0.6015E+00	0.3331E+03	9.984
4014	990.9	0.9543E+02	-0.3597E+01	0.6859E+00	0.3577E+03	10.720
4102	2072.7	0.5200E+02	0.6834E+01	0.4874E+00	0.4482E+03	13.433
4202	2077.3	-0.5724E+02	0.1814E+02	0.1744E+00	0.4352E+03	13.045
4302	2268.2	0.4928E+03	-0.3974E+02	0.1658E+01	0.4329E+03	12.975
4402	2209.1	0.5926E+02	-0.1486E+01	0.6670E+00	0.3592E+03	10.766

TABLE 3 (CONTINUED)
TWIN SMALL ROLL DYNAMOMETER ESTIMATIONS
FOR VEHICLES WITH RADIAL TIRES

ID	GRAVMASS (KG)	F0 (NT)	F1 (KG/SEC)	F2 (KG/M)	F@50 (NT)	HP@50 (HP)
4507	1413.6	-0.1193E+02	0.7797E+01	0.2515E+00	0.2880E+03	8.631
4607	1050.0	0.2209E+02	0.2361E+01	0.3359E+00	0.2426E+03	7.273
4701	1922.7	0.8817E+02	-0.2181E+01	0.6013E+00	0.3398E+03	10.184
4801	1968.2	0.5423E+02	-0.2535E+01	0.7274E+00	0.3609E+03	10.817
4903	1640.9	-0.2160E+02	0.1088E+02	0.1701E+00	0.3065E+03	9.185
5001	1963.6	0.2728E+03	-0.1913E+02	0.1039E+01	0.3642E+03	10.915
5103	1627.3	0.4212E+02	0.1055E+02	0.2431E+00	0.3994E+03	11.972
5203	2200.0	0.7191E+02	0.3683E+01	0.4845E+00	0.3962E+03	11.876
5303	1672.7	0.4619E+02	0.9681E+01	0.2600E+00	0.3924E+03	11.762
5403	1645.4	0.1426E+03	-0.6241E+01	0.7847E+00	0.3951E+03	11.841
5503	2327.3	0.2105E+03	-0.9938E+01	0.8128E+00	0.3944E+03	11.822
5601	1963.6	0.8358E+02	0.3676E+01	0.4269E+00	0.3790E+03	11.359
5603	2200.0	-0.2999E+02	0.1350E+02	0.2314E+00	0.3874E+03	11.610
5701	2168.2	0.2092E+02	0.5547E+01	0.4750E+00	0.3822E+03	11.454
5802	1709.1	0.2062E+02	0.5750E+01	0.4446E+00	0.3712E+03	11.126
6002	2045.4	0.5095E+02	0.9232E+01	0.3783E+00	0.4463E+03	13.375
6102	2345.4	-0.4376E+02	0.1612E+02	0.2086E+00	0.4208E+03	12.612
6202	1945.4	-0.3876E+02	0.1294E+02	0.2446E+00	0.3726E+03	11.168
6302	1709.1	0.6972E+02	-0.3356E+01	0.7182E+00	0.3535E+03	10.594
6402	2300.0	-0.6875E+02	0.1239E+02	0.3583E+00	0.3871E+03	11.603
6502	2368.2	-0.1947E+02	0.6926E+01	0.5551E+00	0.4126E+03	12.367
6702	2272.7	0.4439E+02	0.2241E+01	0.7385E+00	0.4634E+03	13.888
6802	2090.9	0.1688E+03	-0.1115E+02	0.9875E+00	0.4129E+03	12.377
6909	1495.4	-0.4329E+01	0.9895E+01	0.3338E+00	0.3836E+03	11.496
8101	1750.0	0.1883E+03	-0.1099E+02	0.7654E+00	0.3250E+03	9.741
8401	2350.0	-0.2707E+01	0.5436E+01	0.5472E+00	0.3921E+03	11.753
9101	1750.0	0.7218E+02	0.3061E+01	0.4822E+00	0.3815E+03	11.433

TABLE 4
SINGLE LARGE ROLL DYNAMOMETER

ID	GRAVMASS (KG)	F0 (NT)	F1 (KG/SEC)	F2 (KG/M)	F@50 (NT)	HP@50 (HP)
101	2072.7	0.1387E+03	0.1781E+01	0.5860E+00	0.4712E+03	14.123
201	1863.6	0.2484E+03	-0.1013E+02	0.9936E+00	0.5184E+03	15.539
301	1654.6	0.6252E+02	0.9245E+01	0.2000E+00	0.3691E+03	11.061
401	1600.0	0.1690E+03	-0.4689E+01	0.6926E+00	0.4102E+03	12.294
502	1272.7	0.1418E+03	-0.4911E+01	0.7195E+00	0.3915E+03	11.733
601	1931.8	0.2218E+03	-0.1203E+02	0.9457E+00	0.4254E+03	12.749
804	1350.0	0.1907E+02	0.1495E+02	0.1032E+00	0.4047E+03	12.128
901	2386.4	0.8861E+02	0.4310E+01	0.6562E+00	0.5127E+03	15.367
1001	1218.2	0.1084E+03	0.2750E+01	0.4068E+00	0.3731E+03	11.183
1102	1595.4	0.6853E+02	0.5832E+01	0.4610E+00	0.4292E+03	12.863
1201	1881.8	0.1460E+02	0.1359E+02	0.3270E+00	0.4818E+03	14.439
1301	1827.3	0.5499E+02	0.9040E+01	0.3936E+00	0.4536E+03	13.597
1401	1690.9	0.4093E+02	0.1190E+02	0.2255E+00	0.4196E+03	12.575
1501	1777.3	0.6542E+02	0.7702E+01	0.3596E+00	0.4172E+03	12.504
1601	1586.4	0.1361E+03	-0.3345E+01	0.4953E+00	0.3087E+03	9.253
1702	1363.6	0.5855E+02	0.3426E+01	0.4373E+00	0.3537E+03	10.600
1802	1372.7	0.8140E+02	0.3728E+01	0.4544E+00	0.3917E+03	11.740
1901	1454.6	0.1360E+03	-0.3911E+01	0.5647E+00	0.3306E+03	9.910
2102	1168.2	0.9406E+02	-0.2950E+00	0.5188E+00	0.3466E+03	10.389
2203	1636.4	0.1607E+03	-0.5076E+01	0.7477E+00	0.4207E+03	12.611
2301	2213.6	0.6382E+02	0.6487E+01	0.5202E+00	0.4687E+03	14.046
2401	2540.9	0.8628E+02	0.5042E+01	0.6615E+00	0.5294E+03	15.867
2502	2477.3	0.2510E+03	0.3091E+01	0.5077E+00	0.5736E+03	17.193
2602	1068.2	0.6032E+02	0.3141E+01	0.3366E+00	0.2987E+03	8.951
2706	1122.7	0.4960E+02	0.4927E+01	0.3499E+00	0.3345E+03	10.026
2802	1509.1	0.1354E+03	0.1282E+01	0.4602E+00	0.3939E+03	11.807
2906	1254.6	0.1191E+03	-0.6635E+01	0.6477E+00	0.2944E+03	8.822
3011	1231.8	0.1682E+03	-0.6041E+01	0.6943E+00	0.3800E+03	11.390
3102	1509.1	0.7703E+02	0.5343E+01	0.3735E+00	0.3830E+03	11.480
3212	1204.6	0.1578E+03	-0.1089E+02	0.7864E+00	0.3073E+03	9.210
3304	1513.6	0.7287E+02	0.4193E+01	0.3760E+00	0.3544E+03	10.622
3402	1590.9	0.1923E+02	0.1394E+02	0.1693E+00	0.4154E+03	12.451
3505	986.4	0.1157E+03	-0.1010E+01	0.5202E+00	0.3530E+03	10.580
3613	863.6	0.1092E+02	0.8363E+01	0.2122E+00	0.3038E+03	9.106
3712	1204.6	0.6048E+02	0.6644E+01	0.2975E+00	0.3576E+03	10.717
3908	1218.2	0.9622E+02	-0.1072E+01	0.6015E+00	0.3727E+03	11.171
4014	990.9	0.1226E+03	-0.3608E+01	0.6859E+00	0.3846E+03	11.527
4102	2072.7	0.1052E+03	0.6173E+01	0.4874E+00	0.4866E+03	14.586
4202	2077.3	0.3691E+02	0.1864E+02	0.1744E+00	0.5405E+03	16.201
4302	2268.2	0.5825E+03	-0.3968E+02	0.1658E+01	0.5238E+03	15.700
4402	2209.1	0.1644E+03	-0.1534E+01	0.6670E+00	0.4633E+03	13.886

TABLE 4 (CONTINUED)
SINGLE LARGE ROLL DYNAMOMETER

ID	GRAVMASS (KG)	F0 (NT)	F1 (KG/SEC)	F2 (KG/M)	F@50 (NT)	HP@50 (HP)
4507	1413.6	0.2457E+02	0.7695E+01	0.2515E+00	0.3222E+03	9.656
4607	1050.0	0.6428E+02	0.2394E+01	0.3359E+00	0.2856E+03	8.559
4701	1922.7	0.1264E+03	-0.1743E+01	0.6013E+00	0.3877E+03	11.621
4801	1968.2	0.1112E+03	-0.2356E+01	0.7274E+00	0.4220E+03	12.647
4903	1640.9	0.5525E+02	0.1126E+02	0.1701E+00	0.3919E+03	11.746
5001	1963.6	0.3266E+03	-0.1895E+02	0.1039E+01	0.4221E+03	12.652
5103	1627.3	0.7951E+02	0.1210E+02	0.2431E+00	0.4714E+03	14.129
5203	2200.0	0.1629E+03	0.3594E+01	0.4845E+00	0.4852E+03	14.542
5303	1672.7	0.1137E+03	0.9719E+01	0.2600E+00	0.4608E+03	13.812
5403	1645.4	0.2030E+03	-0.5799E+01	0.7847E+00	0.4654E+03	13.948
5503	2327.3	0.2974E+03	-0.9280E+01	0.8128E+00	0.4960E+03	14.866
5601	1963.6	0.1374E+03	0.3860E+01	0.4269E+00	0.4369E+03	13.096
5603	2200.0	0.4170E+02	0.1410E+02	0.2314E+00	0.4724E+03	14.158
5701	2168.2	0.1120E+03	0.6042E+01	0.4750E+00	0.4844E+03	14.517
5802	1709.1	0.9090E+02	0.6171E+01	0.4446E+00	0.4509E+03	13.515
6002	2045.4	0.1270E+03	0.8986E+01	0.3783E+00	0.5168E+03	15.490
6102	2345.4	0.3573E+02	0.1626E+02	0.2086E+00	0.5034E+03	15.087
6202	1945.4	0.7184E+02	0.1297E+02	0.2446E+00	0.4839E+03	14.503
6302	1709.1	0.1400E+03	-0.2935E+01	0.7182E+00	0.4332E+03	12.983
6402	2300.0	0.1428E+02	0.1276E+02	0.3583E+00	0.4784E+03	14.337
6502	2368.2	0.6898E+02	0.7041E+01	0.5551E+00	0.5036E+03	15.095
6702	2272.7	0.1012E+03	0.2358E+01	0.7385E+00	0.5228E+03	15.670
6802	2090.9	0.2276E+03	-0.1104E+02	0.9875E+00	0.4742E+03	14.212
6909	1495.4	0.3735E+02	0.1021E+02	0.3338E+00	0.4323E+03	12.958
8101	1750.0	0.2415E+03	-0.1087E+02	0.7654E+00	0.3810E+03	11.420
8401	2350.0	0.5022E+02	0.5897E+01	0.5472E+00	0.4554E+03	13.648
9101	1750.0	0.1254E+03	0.3185E+01	0.4822E+00	0.4375E+03	13.112