SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE INFORMATION REPORT

SAE J862

REAF. JAN89

Issued 1963-06
Reaffirmed 1989-01

Superseding J862 JUN81

Submitted for recognition as an American National Standard

FACTORS AFFECTING ACCURACY OF MECHANICALLY DRIVEN AUTOMOTIVE SPEEDOMETER-ODOMETERS

Foreword—This Document has not changed other than to put it into the new SAE Technical Standards Board Format.

1. ***Scope***—This report is concerned with factors which affect accuracy of distance indication and speed indication of automotive type odometer speedometers. It is the intent to supply information regarding all items which affect the instrument.

2. ***References***

2.1 **Applicable Publications**—The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated the lastest revision of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J678 JUN84—Speedometers and Tachometers-Automotive
SAE J1059 JUN84—Speedometer Test Procedure

3. ***Distance Indication***—Distance traveled is indicated by a numbered set of wheels, called the odometer, normally viewed through a slot in the dial of the speedometer. The wheels incorporate gear teeth which engage a pinion interposed between each set of wheels. The odometer can then be said to be a set of gears with numerals on their outer surface. The odometer is driven by a system of reduction gearing within the speedometer instrument. This reduction gearing is, in turn, driven by the speedometer cable core. SAE J678 (JUN84) specifies that 1000 or 1001 revolutions of the speedometer cable core shall cause a 1 mile indication on the odometer (616 through 630 revolutions, depending on the odometer gear train drive, for 1 km) if driven from the transmission. In wheel driven speedometers, the nominal number of wheel revolutions per mile (kilometer) shall cause a 1 mile (km) indication on the odometer. Because of the positive gear driven mechanism, no slippage error occurs in the odometer.

4. Factors Affecting Odometer Accuracy

4.1 Overall Assembly in Vehicle—The ideal of achieving the exact nominal value of speedometer cable core revolutions in one unit of distance of vehicle travel can seldom be realized. This becomes apparent when consideration is given to the overall design problem.

4.1.1 The speedometer cable core is driven by a gear called the take off pinion gear which is driven by the worm drive gear connected to the transmission output shaft which, in turn, drives the wheels through the differential gears. The distance traveled is dependent on the number of tire revolutions in a mile (kilometer). By experimentation, a nominal figure of tire revolutions per unit of distance is determined for the vehicle. Knowing the differential ratio, it is possible to calculate the necessary ratio in the transmission and the take off pinion gear for the speedometer cable core to achieve 1000 or 1001 revolutions per mile or 616 through 630 revolutions per kilometer. In the case of an odometer/speedometer driven directly from a wheel, it is then necessary to calculate the proper gearing within the speedometer head itself to achieve nominal conditions.

4.1.2 The exact ratio frequently results in a fraction which must, of course, be rounded to a whole number of teeth for the take off pinion gear. This gear selection must be accurate enough to assure that the odometer records actual distances traveled within ±4% at 20, 40, and 55 mph (32.2, 64.4, and 88.5 km/h) [1].

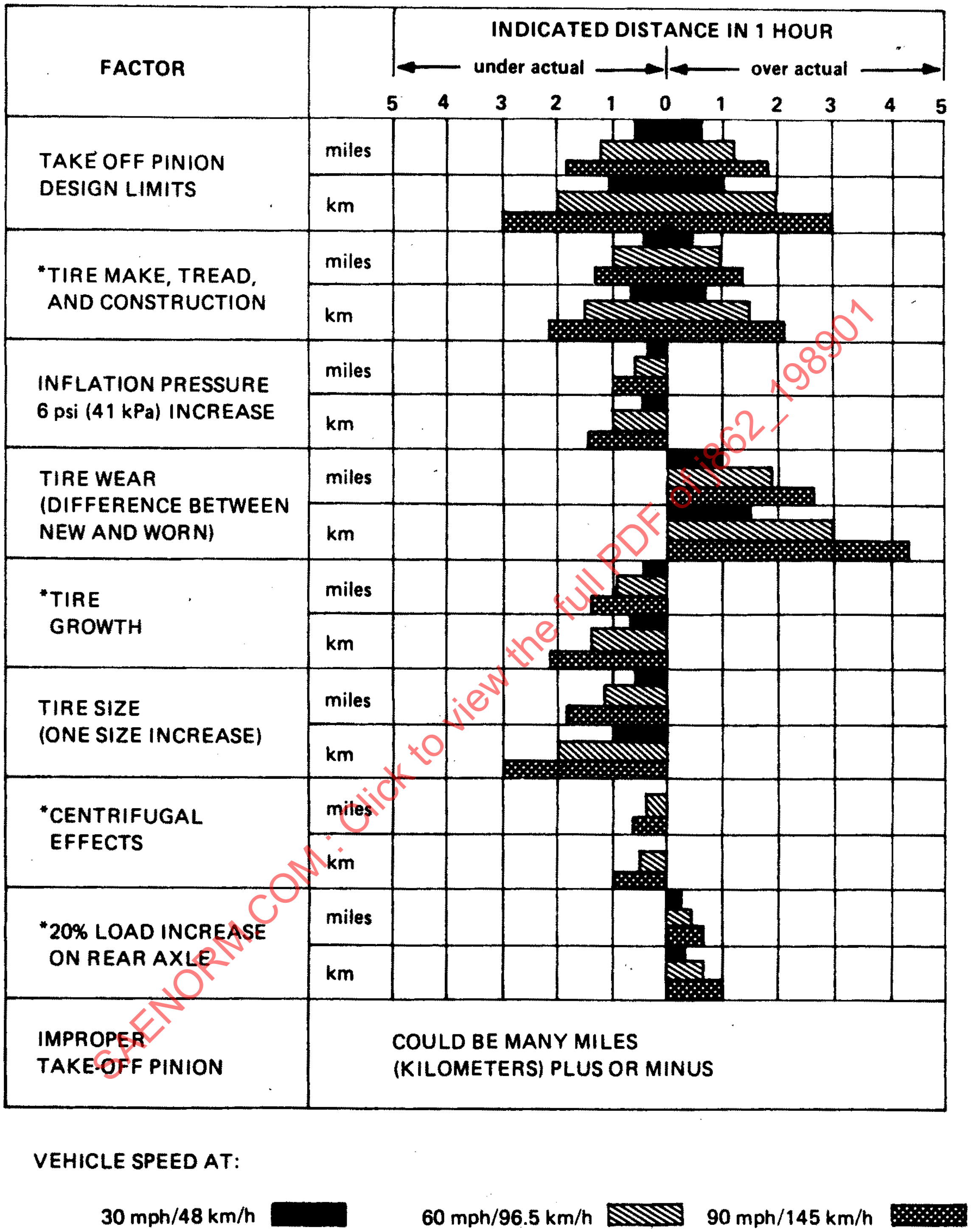
4.1.3 Because of the different axle ratios used, it is necessary in any one line of automobiles to have a variety of take off pinion gears with different numbers of teeth. The number of teeth in the worm drive gear is not readily subject to change, since the gear is assembled within the transmission and is usually uniform for any transmission model.

4.2 Tires and Load—Tires are elastic members subject to variations from nominal size caused by manufacturing tolerances, temperature, inflation pressure, wear, speed, and loading. A tire will change size due to aging, after it is placed on a rim and inflated. These size variations, plus differences in construction material, and in the type of tread on tires from the same or different manufacturers, can result in a different number of tire revolutions per unit of distance. It is obvious that these variations from the nominal originally selected can directly affect distance indication.

4.3 Speed—A tire may experience as much as a 3% change in revolutions per unit of distance from a 30 mph (48.3 km/h) speed to a 90 mph (144.8 km/h) speed due to a change in rolling radius by centrifugal force.

4.4 Analysis and Summary—Figure 1 is a chart which demonstrates the magnitudes of error which might occur in odometer readings. The average individual effect will be less than the maximum indicated by the chart since some of the conditions tend to compensate for others. For instance, tire wear and aging growth are compensating factors. Tire wear has the effect of increasing odometer indication and the tire aging growth will decrease the indication. When reading the chart, however, it should be appreciated that the errors may be additive.

1. See SAE J678 for specific state or local requirements.



*VALUES SHOWN ARE FOR BIAS PLY TIRES. RADIAL AND BELTED TIRES ARE AFFECTED A LESSER AMOUNT.

FIGURE 1—FACTORS WHICH AFFECT ODOMETER READINGS CROSS SECTION OF ALL U.S. MAKES

4.5 Corrective Measures

4.5.1 In the foregoing, it has been shown that there are factors present which cannot be economically reduced or controlled which will cause distance indication errors. Some of the factors, however, can, in some degree, be controlled by proper tire inflation and replacement of worn tires.

4.5.2 Inadvertent installation of an improper pinion gear for a particular axle ratio will, of course, result in considerable error in odometer reading. Such a condition is, however, easily remedied by installation of the correct take off pinion gear.

4.5.3 A vehicle operator, especially one who modified a standard vehicle, can determine his percentage of odometer error by driving an accurately known distance at approximately nominal operating conditions of speed, load, temperature, and proper tire inflation. The reading of the odometer shall be compared to the known distance traveled. A reading greater than the distance traveled indicates a plus error, conversely a reading less than the distance traveled, indicates a minus error. For example, if the odometer indicates 5.2 miles (km) as compared to a nominal 5.0 miles (km) distance traveled, an error of 0.2 divided by 5.0 or +4% exists. A grossly plus error may be compensated for by using a take off pinion gear with a greater number of teeth or a large minus error may be corrected with a take off pinion gear with less teeth.

5. Speed Indication—Speed indication in an automotive speedometer is commonly accomplished through the use of a principle known as eddy current drive. The speedometer cable core drives a magnet shaft of the speedometer to which a permanent magnet is affixed. This magnet is located inside an aluminum or copper speed cup. The speed cup is attached to the same spindle on which the speedometer pointer is affixed. Also affixed to this spindle is a hairspring. A force applied to the speed cup results in a controlled reaction of the speedometer pointer. As the magnet rotates inside the speed cup, a force proportional to the speed of rotation is developed, thus providing measurement of speed indicated on the dial (Figure 2).

6. Speedometer Calibration—The speedometer is calibrated at room temperature 75°F (23.9°C) by the instrument manufacturer. See SAE J678 for the recommended calibration tolerances.

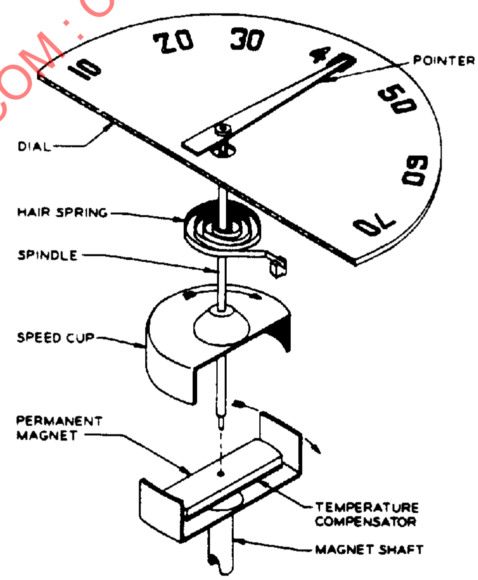


FIGURE 2—EDDY CURRENT DRIVE