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Examination of Distance Measuring Devices

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Examination of Distance Measuring Devices

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PREFACE

This publication is one of a number of Handbooks of the National Bureau of Standards (NBS) designed to present in compact form comprehensive technical guides for State and local weights and measures officials. This particular Handbook treats the examination of distance measuring devices. The Handbook is part of a series which will supersede NBS Handbook 45, "Testing of Measuring Equipment." Each of the several types of measuring devices is being considered separately in acknowledgment of the increasing specialization in weights and measures supervision, the rapidly developing technological character of commercial measurement, and the ever-changing equipment utilized in the measurement process.

Authority for such activity on the part of the Bureau is found in basic legislation (64 Stat. 371) wherein the Bureau is authorized to undertake, among others, the following functions: "cooperation with the States in securing uniformity in weights and measures laws and methods of inspection," and "The compilation and publication of general scientific and technical data resulting from the performance of the function specified herein or from other sources when such data are of importance to scientific or manufacturing interests or to the general public, and are not available elsewhere...."

This publication is intended primarily for use when testing with a measured course, with fifth-wheel test equipment, or by a simulated road test. Other test procedures are in existence and others probably will be developed in the future. This publication is not intended to limit the testing of the devices to these particular test procedures.

Except for some common considerations, each of the procedures is designed to be used without reference to other parts of the Handbook. Accordingly, parts of some of the procedures are the same as corresponding parts of other procedures.

The Handbook has been prepared to be used with metric as well as inch-pound units.* Wherever applicable, separate tables have been provided in inch-pound units and metric. Few decisions concerning metric equivalents (not a direct conversion) have thus far been made; such equivalents are given in this Handbook in square brackets and are applicable only to devices that read out in metric units. The metric values in parentheses are of the "soft conversion" type (direct conversion) and are applicable to all devices. To assist the reader, all metric and inch-pound units are defined with respect to each other in the "Definitions" and sample report-data tables have also been prepared using metric units.

Although this Handbook is prepared primarily for use by weights and measures officials of States, counties, and cities, it is believed that the information presented will be useful to manufacturers and commercial and industrial establishments interested in the accuracy and calibration of distance measuring devices.

*Term used in accordance with definition given in section 1.1, Definition of Terms.

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EXAMINATION OF DISTANCE-MEASURING DEVICES

This is a manual for State and local weights and measures officials, describing the devices to be tested, testing equipment and its calibration, inspection and testing procedures, and a reporting system. Provision is made for accommodating a changeover to metric units of device registration in the definitions, tables, procedures, and reporting a test.

Key words: Calibration; distance; fifth wheel; inspection; measured course; odometer; taximeter; test procedure; tire pressure; tolerances.

1. INTRODUCTION

This manual is designed to include the various procedures that may be used in the examination of taximeters and odometers that are used as commercial measurement devices. The procedures have been developed to be used in conjunction with National Bureau of Standards Handbook 44, "Specifications, Tolerances, and Other Technical Requirements for Commercial Weighing and Measuring devices."

Handbook 44 allows the use of more than one procedure in the examination of these devices because no single procedure is suitable for every jurisdiction. Test areas and facilities required will vary with the traffic congestion, climate, location and other factors in the jurisdiction.

1.1. DEFINITIONS OF TERMS.- Many of the definitions are given in Handbook 44, "Specifications, Tolerances, and Other Technical Requirements for Commercial Weighing and Measuring Devices,"[1] but they are repeated here for the reader's convenience.

acceptance tolerances. Acceptance tolerances shall apply as follows:

(a) To any equipment about to be put into commercial use for the first time.
(b) To equipment that has been placed in commercial service within the preceding 30 days and is being officially tested for the first time.
(c) To equipment that has been returned to commercial service following official rejection for failure to conform to performance requirements and is being officially tested for the first time within 30 days after corrective service.
(d) To equipment that is being officially tested for the first time within 30 days after major reconditioning or overhaul.[1]

basic distance rate. The charge for distance for all intervals except the initial interval.[1]

basic time rate. The charge for time for all intervals except the initial interval.[1]

cleared. A taximeter is "cleared" when it is inoperative with respect to all fare indication, when no indication of fare or extras is shown, and when all parts are in those positions in which they are designed to be when the vehicle on which the taximeter is installed is not engaged by a passenger.[1]

cold tire pressure. The pressure in a tire when the tire is at ambient temperature.[1]

extras. Charges to be paid by a passenger in addition to the fare, including any charge at a flat rate for the transportation of passengers in excess of a stated number and any charge for the transportation of baggage.[1]

distance-interval test. Test conducted in a taximeter with respect to its initial and subsequent distance intervals.

face. That side of a taximeter upon which passenger charges are indicated.[1]

fare. That portion of the charge for the hire of a vehicle that is automatically calculated by a taximeter through the operation of the distance or time measuring element.[1]

[1]Superscript numbers refer to references at the end of the handbook.

fifth-wheel test. A distance test similar to a road test except that the distance traveled by the vehicle under test is determined by a field transfer standard known as a "fifth wheel" that is attached to the vehicle and that independently measures and indicates the distance.[1]

flag. A plate at the end of the lever arm or similar part by which the operating condition of some taximeters is controlled.[1]

flag drop. See initial money drop.

hired. A taximeter is "hired" when it is operative with respect to all applicable indications of fare or extras. The indications of fare include time and distance where applicable unless qualified by another indication of "Time Not Recording" or an equivalent expression.[1]

inch-pound units. Units, based upon the yard, gallon, and pound units commonly used in the United States of America. Note that units having the same names in other countries may differ in magnitude.

initial distance or time interval. The interval corresponding to the initial money drop.[1]

initial money drop. The first increment of fare indication upon activation of taximeter.

interference test. A test designed to determine interference between the time- and distance-recording mechanisms.

kilometer. A kilometer (km) is the metric unit of measure for distance that is used in metric taximeters. It is the preferred unit of length when converting from miles to metric units. A kilometer is equivalent to 0.62137 mile.[2]

kilogram. A kilogram (kg) is the preferred metric unit of mass when converting from avoirdupois pounds to metric units. A kilogram is equivalent to 2.204 623 pounds.[2]

kilopascal. A kilopascal (kPa) is the preferred derived metric unit when converting from pounds per square inch (psi) to metric units (kilonewtons per square centimeter). A kilopascal is equivalent to 0.145 037 7 psi.[3]

maintenance tolerances. Maintenance tolerances shall apply to equipment in actual use, except as provided in definition of acceptance tolerances.[1]

maximum cargo load. The maximum cargo load for trucks is the difference between the manufacturer's rated gross vehicle weight and the actual weight of the vehicle having no cargo load.

mile. A mile is the inch-pound unit of measure for distance that is used in present U.S. taximeters. A mile is equivalent to 1.609 344 kilometers.[2]

money drop. An increment of fare indication.[1]

multiple-rate taximeter. One that may be set to calculate fares at any one of two or more rates.[1]

odometer. A device that automatically indicates the total mileage traveled by a vehicle. This definition includes hub odometers, cable-driven odometers, and the distance indicating portions of "speedometer" assemblies for automotive vehicles.

operating tire pressure. The operating tire pressure posted in the vehicle and determined after the tire pressures have been stabilized by a run of at least 5 miles [8 kilometers].[1]

overregistration and underregistration. When an instrument or device is of such a character that it indicates or records values as a result of its operation, its error is said to be in the direction of overregistration or underregistration, depending upon whether the indications are, respectively, greater or less than they should be. A taximeter or odometer overregisters when it indicates more than the true distance and underregisters when it indicates less than the true distance.

passenger vehicles. Vehicles such as automobiles, recreational vehicles, limousines, ambulances, and hearses.

pound. A pound is an avoirdupois unit of mass. A pound is equivalent to 0.453 592 37 kilogram.[2]

pound per square inch. Pound per square inch (psi) is the inch-pound unit of pressure. One psi is equivalent to 6.894 757 kilopascals in the metric system.[3]

road crown. The slope of the road surface.

road test. A distance test, over a measured course, of a complete taximeter or odometer assembly when installed on a vehicle, the device being actuated as a result of vehicle travel.[1]

rolling circumference. The rolling circumference is the straight line distance traveled per revolution of the wheel (or wheels) that actuates the taximeter or odometer. In the case where more than one wheel actuates the taximeter, the rolling circumference is the average distance traveled per revolution of the wheels.[1]

security seal. A lead-and-wire seal, or similar device, attached to a device for protection against access, removal, or adjustment.[1]

simulated-road test. A distance test during which the taximeter or odometer may be actuated by some means other than road travel. The distance traveled is either measured by a properly calibrated roller device, or computed from rolling circumference and wheel-turn data.[1]

single-rate taximeter. One that calculates fare at a single rate only.[1]

stabilized tire pressure. The pressure of a tire after being driven for at least 5 miles [8 kilometers].

statement of rates. The distances and time rates for which a taximeter is adjusted and the schedule of extras when an extras mechanism is provided.

subsequent distance or time interval. The intervals corresponding to the subsequent money drop.[1]

subsequent money drop. The increment of fare indications following the first fare indication.

time-interval test. Test conducted on a taximeter with respect to its initial and subsequent time intervals.

"time not recording" position. A trade term indicating that the taximeter fare is based on distance only.

taximeter. A device that automatically calculates, at a predetermined rate or rates, and indicates, the charge for hire of a vehicle.[1]

1.2. DEVICE DESCRIPTION.- Taximeters and odometers are two distance measuring devices for hired vehicles recognized by Handbook 44 as commercial measuring devices. Both are driven (directly or indirectly) by a wheel or pair of wheels of the vehicle. Critical factors affecting taximeter and odometer accuracy are tire type, pressure, size, and inflation since they significantly control the rolling circumference of the wheel or wheels.

1.2.1. TAXIMETER.- According to Handbook 44, a taximeter is a commercial measuring device that automatically computes and indicates at a predetermined rate or rates the charge for hire of a vehicle such as a taxicab. It consists primarily of a distance measuring mechanism and a timing element driving a fare-indicating mechanism. There are at the present time two basic types of taximeters in use, namely, the mechanical type and the electronic type. The older mechanical type is referred to as such since the heart of its operation is a gear train. The gear train utilized for distance measurement is in most cases actuated by the rear wheels of the vehicle through the transmission and speedometer cable. The clock movement (mechanical, electrical, or electronic) is used in situations where the fare is based upon time and distance. Thus, it would be used for periods of waiting time or for those periods where the charge for time exceeds the charge for distance.

An illustration of the face of a mechanical taximeter is given in Figure 1. It will have a flag or push buttons and appropriately illuminated indications to show that the meter is in the "vacant" or "not registering" position, in the "hired" position (fare based on time and distance), or "time not recording" position (fare-based on distance only). It may also have provision for multiple distance rates (i.e., a city rate and a suburban or out-of-city rate). The meter will also have windows for indicating the fare charges. Optional items that may also be included are "extras" indicators for use in recording additional fixed charges for extra baggage, extra passengers, and similar extra charges and totalizer indicators showing total units, trips, paid distance, total distance, and extras units.

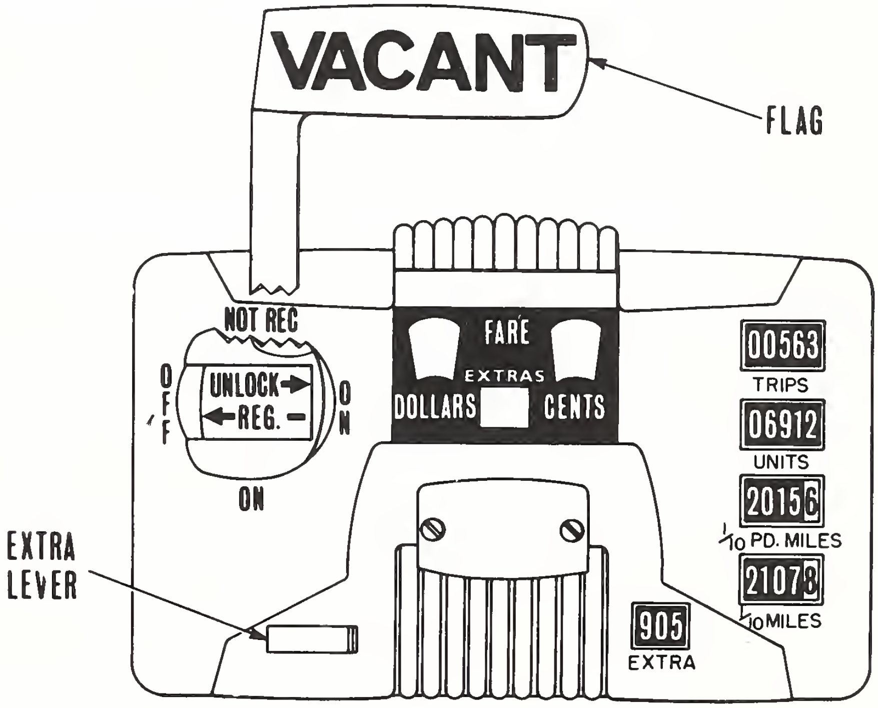


Figure 1. The face of a mechanical taximeter.

The flag or push buttons activate or deactivate the appropriate gear trains and/or clock mechanisms as required in the proper operation of the taximeter. A portion of such a meter is illustrated in Figure 2. In the "hired" position the clock drive and the distance drive compete to trip the fare drum. Both drives attempt to turn the same cam shaft. A one-way clutch on the shaft at each of the drives lets the slower drive slip. In the "time not recording" position the clock mechanism is disengaged and the cam shaft is driven only by the distance drive. When the taximeter is in "vacant" or "not registering" position both the distance and clock drive and any optional features except the total distance totalizer are disengaged.

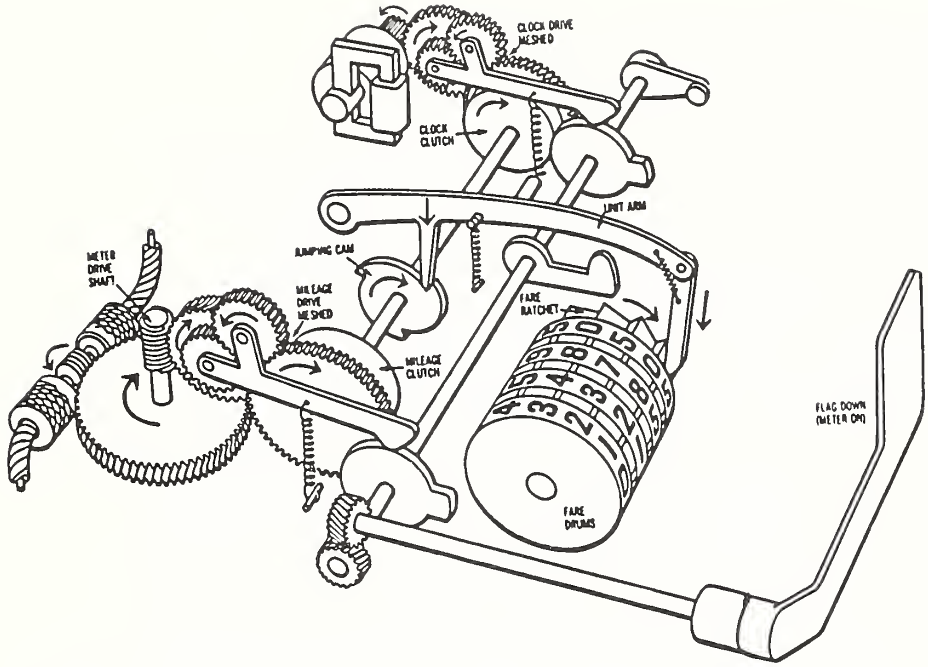


Figure 2. A schematic of the fare driving mechanism of a typical taximeter (flag operated)[4]. Reprinted from Popular Science with permission 1960 Times Mirror Magazines, Inc.

The electronic type of taximeter is a more recent development. Most electronic models do not use gear trains. The face of an electronic taximeter is illustrated in Figure 3. A schematic of one type of electronic taximeter is shown in Figure 4. In this taximeter, a transducer picks up signals optically from the speedometer cable. The signals are then electronically processed and converted to a direct current (DC) voltage that represents the speed of the vehicle. The DC voltage controls an oscillator which generates one pulse per unit of fare. When the speed is such that the distance rate is less than the time rate the DC potential developed is ignored by the system which then applies a fixed voltage to a voltage-controlled oscillator to provide accurately timed drops. The pulse from the oscillator is then fed to a digital board that drives the counter and accumulates and displays the fare, and that can be programmed for flag fall, drop, and "extras."

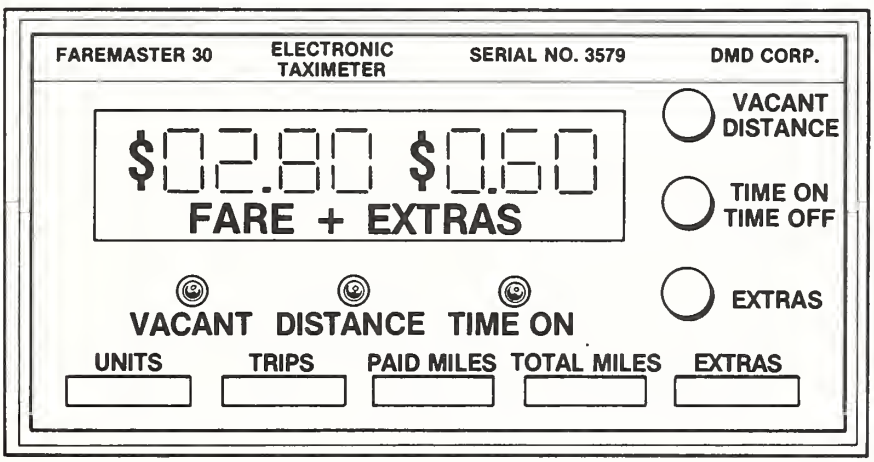


Figure 3. The face of an electronic taximeter.

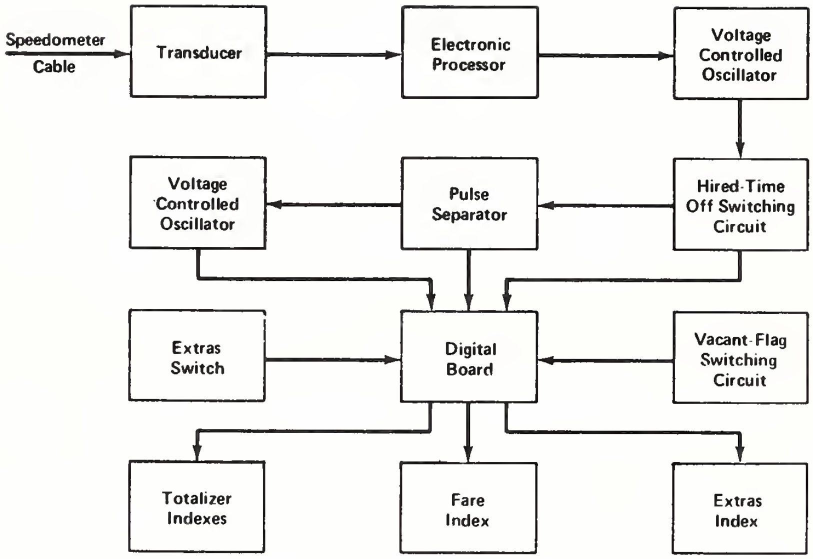


Figure 4. A block diagram of one type of electronic taximeter.

Optional items such as "extras" indications, a temporary summation of fare and "extras," and totalizer indications are also provided.

Both types of taximeters are designed to be adjusted to operate at different rates of fare for distance and waiting time. Adjustments may be made with respect to (1) the value of the initial money drop (flag drop), (2) the value of subsequent money drops, (3) the initial distance interval, (4) the subsequent distance interval, (5) the initial time interval, (6) the subsequent time interval, and (7) the "extras" unit.

Taximeters may register distance in inch-pound units (miles) or in metric units (km).

1.2.2. ODOMETERS.- An automobile odometer is a distance-measuring device indicating in units of miles [km]. The primary indicating element of an odometer may be (a) the distance traveled portion of the "speedometer" assembly of a motor vehicle (Figure 5), (b) a special cable-driven distance-indicating device (Figure 6), or (c) a hub odometer attached to the hub of a wheel on a motor vehicle (Figure 7). When the vehicle is in motion the most sensitive indicating element of a mechanical odometer advances continuously (analog) and that of an electronic odometer advances intermittently (digital).

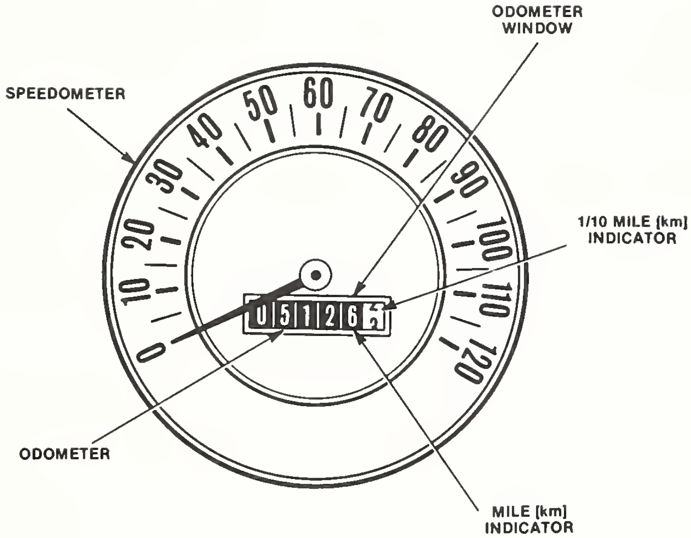


Figure 5. Typical speedometer-odometer assembly of a motor vehicle.

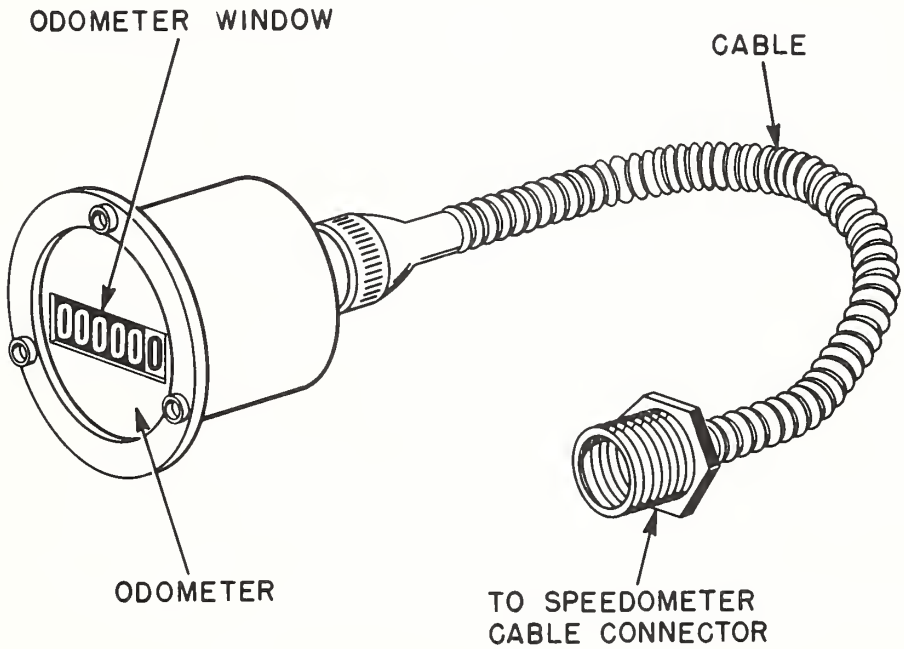


Figure 6. A special cable-driven odometer.

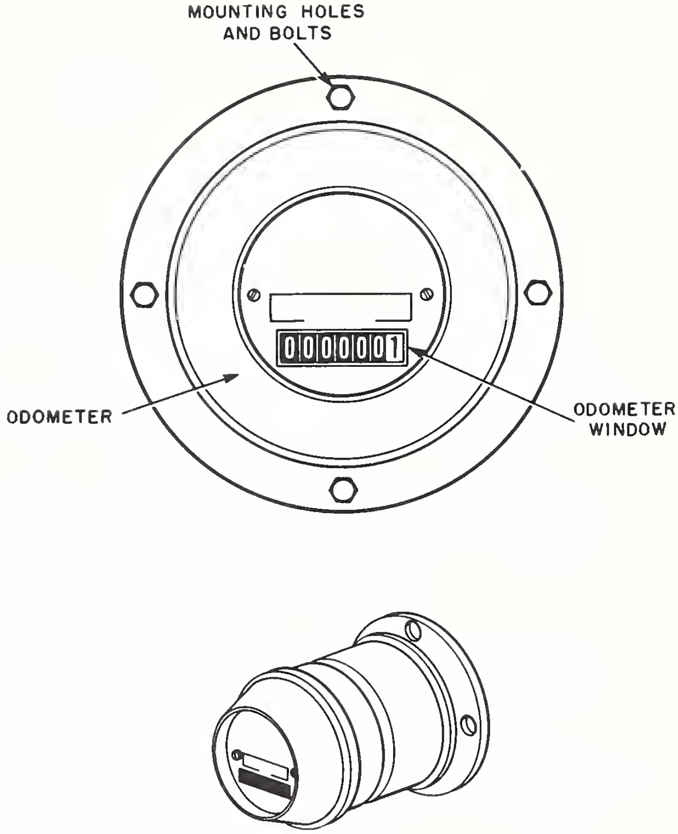


Figure 7. A hub odometer.

2. TESTING METHODS

The time-interval test of a taximeter consists of timing the intervals of initial and subsequent money drops and evaluating the test results on the basis of the accuracy of the "individual time intervals" and the "average time interval." The tests are conducted with the vehicle stationary, thus deactivating the distance-measuring mechanism.

The interference test is a test designed to detect overregistration of the taximeter caused by interference between the time mechanism and the distance mechanism when operated in the "hired" position.

The interference test of a taximeter and the distance test of a taximeter and odometer may be conducted as a road test, a fifth-wheel test, or a simulated road test. A road test is conducted by driving the vehicle over an accurately measured road course. A fifth-wheel test consists of driving the vehicle over a road course and determining the distance actually traveled through the use of a distance measuring standard (fifth wheel) attached to the vehicle that independently measures and indicates the distance. A simulated road test consists of determining the distance traveled by use of a roller device, or by computation from rolling circumference and wheel-turn data.

3. TESTING APPARATUS

All test procedures whether measured course, fifth-wheel, or simulated road test will require tire pressure gages, (accurate to within ± 0.5 psi [3 kPa]), a 100-foot [30-meter] steel surveyor's tape, three 50-pound [three 20-kg and one 10-kg] field test weights, a straight-face spring scale of at least 10-pound [5-kg] capacity (accurate to within ± 1 percent at indications of 5 pounds [2.5 kg] or higher), and a complete-immersion-type thermometer with 1 °F [1 °C] graduations, a range of -30 °F to 120 °F [-35 °C to 50 °C], and an accuracy of ± 2 °F [± 1°C]. The calibration of the above items must be made with standards calibrated by NBS or working standards calibrated with such standards.

3.1. TIME-INTERVAL TEST EQUIPMENT.- The time-interval tests are made with a calibrated stopwatch or timer. Mechanical stopwatches used for these tests should meet the specifications outlined in Federal Specification GG-S-764C (Stopwatch, Laboratory).[5] Specifications for watches with start-stop (single action) and start-stop-elapsed time (double action) features, and adjusted for operation in three positions are applicable. Stopwatches and timers must be calibrated with standard time signals as described in NBS Special Publication 432 NBS Time and Frequency Dissemination Services.[6] The time signals can be received by telephone in the contiguous 48 states and Hawaii with an uncertainty of not more than 30 milliseconds.

To meet legal requirements, it is suggested that stopwatches be certified annually by the weights and measures laboratory. It should be borne in mind, however, that a stopwatch, unlike other field standards, is a mechanical, electrical, or electronic device and may be damaged with no visible indications. Therefore, even if the stopwatch has been certified by the weights and measures laboratory, it could conceivably be in error beyond a tolerance of four seconds in 6 hours [5] at some date after certification. Thus, it is the inspector's responsibility to test his stopwatch at least once a month to see that it remains within certification tolerances.

3.2. MEASURED-COURSE EQUIPMENT. A measured course is the field or working standard that is used in testing distance-measuring devices. The general procedure and considerations followed in the layout of any measured course is discussed in Section 3.3.2.1., Layout of Calibration Course. The specific design and layout of a measured course for taximeters is outlined in Section 5.1.2.1. Design and Layout of a Measured Course. Other equipment requirements are two body jacks, tire pressure gages, a 100-foot [30-meter] tape measure, three 50-pound [three 20-kg and one 10-kg] weights, and a 10-pound [5-kg] weight.

3.3. FIFTH-WHEEL TEST EQUIPMENT.- The fifth wheel is a commercially -available distance-measuring device recommended for use by weights and measures officials as a field transfer standard for testing the accuracy of taximeters and odometers on rented vehicles. The instrument is an accurate distance-measuring device (its error is less than 10% of the smallest applicable tolerance (1%)). However, it requires calibration at periodic intervals to maintain its accuracy. A calibrated fifth wheel may also be used to lay out a taximeter or odometer measured course.

3.3.1. DESCRIPTION OF FIFTH WHEEL.- A schematic drawing of a fifth-wheel assembly is shown in Figure 8. Certain components of the assembly are described referring to the nomenclature shown in the illustration.

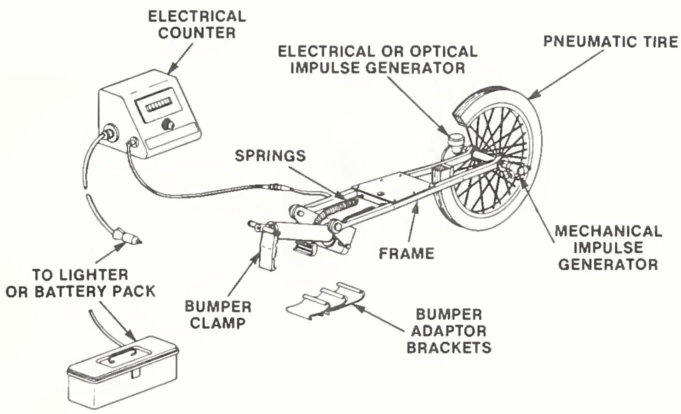


Figure 8. A schematic drawing of a typical fifth-wheel assembly.

The wheel assembly consists of a tire, rim, spokes, hubs, bearings, and electrical-, optical-, and/or mechanical-impulse generators. The tire is a 26 x 2.125 inch (66 x 5.4 cm) pneumatic bicycle-type tire selected for good balance. The wheel consists of a balanced heavy-duty bicycle-type rim with 36 (106 gage) spokes and equipped with essentially frictionless, large-diameter, heavy-duty, double-row, sealed ball bearings.

Electrical-, optical-, and/or mechanical-impulse generators are mounted on the ends of the wheel-assembly axle.

The frame provides the necessary rigid support for the wheel assembly on one end and the bumper clamp on the other end. The bumper clamp is supplied with several adaptors or a universal adaptor for the various bumper configurations in use. A pair of matched springs is attached to the frame and bumper clamp in such a manner that it provides constant pressure of the tire on smooth road when the wheel is in use and holds the wheel in a vertical position when not in use. Support should be provided for the mounting of a warning flag and connections from the impulse generators.

The distance-indicating system which is used in the procedures herein includes an electrical counter, a 20-foot (6-meter) connecting cable, and an auxiliary 12-volt battery pack (battery pack is not usually provided). The electrical counter may be powered by a 12-volt source through the cigarette lighter on the vehicle under test or by the auxiliary battery pack. The battery pack is an assembly of four 6-volt dry cells wired in a series-parallel arrangement to provide 12 volts. The 20-foot (6-meter) connecting cable permits the electrical counter to be located on the front seat or dash board of the vehicle under test. An additional 20-foot (6-meter) connecting cable can be added for the power source to permit locating the electrical counter near the fifth wheel when the cigarette lighter is the power source.

3.3.2. FIFTH-WHEEL CALIBRATION.- A fifth wheel must be calibrated on a carefully selected and accurately measured road course. A concrete or "black-top" asphalt roadway having no loose stones or gravel is preferred over macadam because of the marking or tacking required during measurement. The site should consist of 1 1/4 to 1 1/2 miles [2 1/2 to 3 km] of flat straight road with little traffic. A four-lane or divided road is preferred. If a flat and straight road cannot be found, one with a gentle hill may be tolerated, but hazards to personnel and traffic should be minimized. The crown of the road should not exceed 2 percent (i.e., 0.02-unit rise per unit of width).

3.3.2.1. LAYOUT OF MEASURED COURSE.- The plans for the measured course should be fully discussed with the appropriate highway authority (State or Local Road Commission). They also may offer assistance in the layout.

The laying out of a one-mile [2-km] course can be completed in one day using three or four men. One man is needed to hold the tape at the initial mark, a second to hold the tape under tension while measuring and to keep a record of the measurements, and a third man to mark or tack the 100-foot [30-meter] intervals as measured (see fig. 9). The fourth man would act as a flagman and could move the vehicle, which should be equipped with "4-way" hazard warning lights, or other safety lights. The following equipment will be needed to lay out the course:

(a) A 100-foot [30-meter] steel surveyor's tape standard;

(b) A calibrated six-inch [15-cm] steel rule (optional);

(c) A calibrated straight-face spring scale of at least 10-pound [5-kg] capacity;

(d) Masonry nails and fiber-tip marking pen, or surveyor's tacks;

(e) Hammer;

(f) Paint;

(g) Thermometer (complete immersion type), 1 °F [1 °C] graduations;

(h) Fluorescent safety vests;

(i) High visibility traffic cones;

(j) Fluorescent safety flags.

Figure 9. Laying out a measured course.

Safety should be the primary consideration in the selection of the starting position. Clear visibility of at least 1500 feet [500 m] will give oncoming vehicles adequate stopping distance if needed. The use of safety equipment such as fluorescent vests and traffic cones or pylons is also recommended.

Step 1. Mark starting point permanently with a case-hardened masonry nail embedded in the road surface two feet (60 cm) from the edge of the roadway. Paint a circle around the marker and a perpendicular line from the marker to the road edge.

Step 2. Attach thermometer to steel tape near zero mark on tape with masking tape in such a manner that thermometer will be in contact with tape.

Step 3. Initiate measurement of one-mile [2-km] test course. Place 100-foot [30-meter] mark of steel tape in line with the exact center of starting marker, lay out tape on road and hold under the prescribed tension (usually 10 pounds-force) as determined with a straight-face spring scale. Mark or tack roadway surface at the zero mark on the tape. Read and record tape temperature. Scribe the marker or tack with the exact measurement line (see Figure 9). Spot the mark or tack with a circle of paint, to facilitate relocating it.

Step 4. Continue this measuring and temperature recording procedure in a line parallel with, and two feet (60 cm) in from, edge of roadway until exactly one mile [2 km] is measured with the tape. Note that one mile is 52 lengths of the 100-foot tape plus 80 feet and that two kilometers are 66 lengths of the 30-meter tape plus 20 meters.

> CAUTION: Do not drag the tape on the road surface between measurements. The tape must be lifted off the ground each time it is moved to a new position. Handle carefully so thermometer is not broken.

Step 5. Average tape temperatures recorded in Steps 3 and 4 for each 100-foot [30-meter] increment (or fraction thereof) measured.

Step 6. Move exactly three feet [one meter] down the road beyond the one-mile [2-km] mark, and establish a new temporary starting point for the reverse direction.

Step 7. Repeat the procedure of steps 3, 4, and 5 in the reverse direction along the same route. Mark with paint in a different manner (i.e., spot, square, or half circle) to avoid confusing marks with marks from original measurement. The finish point should be three feet [one meter] short of the permanently-marked starting point (plus or minus five inches [15 cm]).[a] If this agreement is lacking (except for differences accounted for by temperature difference) the measurement procedure should be thoroughly reviewed for sources of error and the entire lay out procedure repeated. The true one-mile [2-km] point will be determined after making corrections for temperature and error in the tape.

Step 8. Since steel tapes are calibrated at 68 °F [20 °C], a correction must be made for the length of the tape at the temperature of use. The change in length amounts to 0.00774 in/°F on a 100-foot steel tape and 0.03483 cm/°C on a 30-meter steel tape. This can be converted with sufficient accuracy to 13/32 in/°F for each measured mile or 1.15 cm/°C for each measured kilometer. To obtain the total correction multiply this change in tape length per °F [°C] and per mile [km] by the difference between the average temperature and 68 °F [20 °C] and by the measured miles [km] respectively. If the average temperature is more than 68 °F [20 °C] the expansion of the tape will make it longer and the correction is subtracted. Conversely, if the average temperature is less than 68 °F [20 °C] the tape would contract and be shorter and the correction would be added. To repeat, if the average temperature is more than 68 °F [20 °C] subtract the computed temperature correction, and if the average temperature is less than 68 °F [20 °C] add the computed temperature correction. The formula derived for inch-pound units is:

$$Lc = \frac{13}{32} T_d M$$

where:

L_c = temperature correction (in)

T_d = temperature difference (°F) from 68 °F (68 °F - average temperature (°F))

M = length of course (miles)

For example, if the average tape temperature were 81 °F, and the measured course were 1 mile:

applying these figures to the formula, the computation would be

$13/32 \times (68 - 81) \times 1 = 13/32 \times (-13) \times 1 = -5.28$ or $-5\ 9/32$ in

The minus sign indicates that the correction is subtracted. The formula derived for metric units is:

$$L_c = 1.15\ T_d\ M$$

where:

L_c = temperature correction (cm)

T_d = 20 °C - Average temperature (°C)

M = length of course (km)

[a]This is a tentative tolerance figure based on experience of personnel with some preliminary training. Exceeding this tolerance usually indicates either (1) presence of gross errors in one or both measurements, or (2) improper tape handling. Some possible sources of error are errors in scribing, tape tension, tape reading, temperature measurement, and tape handling.

The computation would be similar except that 20 °C is used as the base temperature and all units used would be metric as defined. A sample calculation for an average temperature of 30 °C and a measured course of two kilometers is as follows.

$$1.15 \times -10 \times 2 = -\ 23 \text{ cm}$$

Since the temperature is above 20 °C the tape has expanded and as noted with the minus sign the correction is subtracted.

Step 9. Correct for error in the tape as certified. To illustrate, the tape was certified to be 100.003 feet long at 68 °F under the prescribed calibration tension of 10 pounds force. Thus, the tape has an error of +0.003 feet. In laying out a one-mile (5,280-ft) course, the 100-foot tape was used 52.8 times. With an error of + 0.003 feet, the tape error would be computed as + 0.003 ft x 52. 8 = 0.1584 ft. In converting to inches, 0.1584 ft x 12 = 1.90 inches. As the tape is actually longer than 100 feet, the correction must be subtracted. A corresponding correction would be made for a metric tape. For example, a 30-meter tape was certified to be 30.0010 meters long at 20 °C under the prescribed calibration tension. With an error of +0.001 m multiplied by the number of tape lengths in two kilometers:

$$0.001 \text{ m} \times 66.67 = 0.0667 \text{ meter} = 6.7 \text{ cm}$$

Since the tape is longer than 30 meters the correction must be subtracted.

Step 10. Summarize corrections. The measurement would then have corrections as follows

	One Mile Course	Two Kilometer Course
Temperature correction	-5.28 in	-23.0 cm
Tape error	-1.90 in	- 6.7 cm
Correction for first measurement	-7.18 or -7 3/16 in	-29.7 cm

Repeat development of corrections for second measurement. Determine the final correction as follows:

$$\text{Final Correction} = \frac{\text{Correction for first measurement}}{2} + \frac{\text{Correction for second measurement}}{2} - \frac{\text{Difference between measurements}}{2}$$

where:

Difference between measurements = distance between starting point of first measurement and finish point of second measurement (temperature corrected) minus the 3 feet [1 m] set off distance between the first and second measurements (retain arithmetic sign)

Step 11. Using the correction determined in Step 10, move the original starting point and embed another masonry nail marker permanently into the roadway to identify the correct starting point. If the correction is minus shorten the first measured distance by the appropriate amount and if the correction is plus lengthen the first measured distance appropriately. This true or correct one-mile [2 km] starting marker is spotted by painting a circle around the marker and then a perpendicular line from the circle to the road edge. The permanently embedded markers indicate the starting and finishing points of an accurately-measured one-mile [2 km] course. Erect start and finish identification signs at the proper markers. (The State or Local Road Commission may have some specifications or recommendations for these markers.)

3.3.2.2. FIFTH-WHEEL CALIBRATION PROCEDURE.- A following motorist may have difficulty seeing the fifth wheel in its test position. If not supplied by the manufacturer, a warning flag should be made and attached to the frame of the device next to or over the wheel in such a manner that it is at eye-level to the driver of a following vehicle (see Fig. 10). In addition, the four-way hazard warning signals of the test vehicle should be operating whenever a test is being conducted.

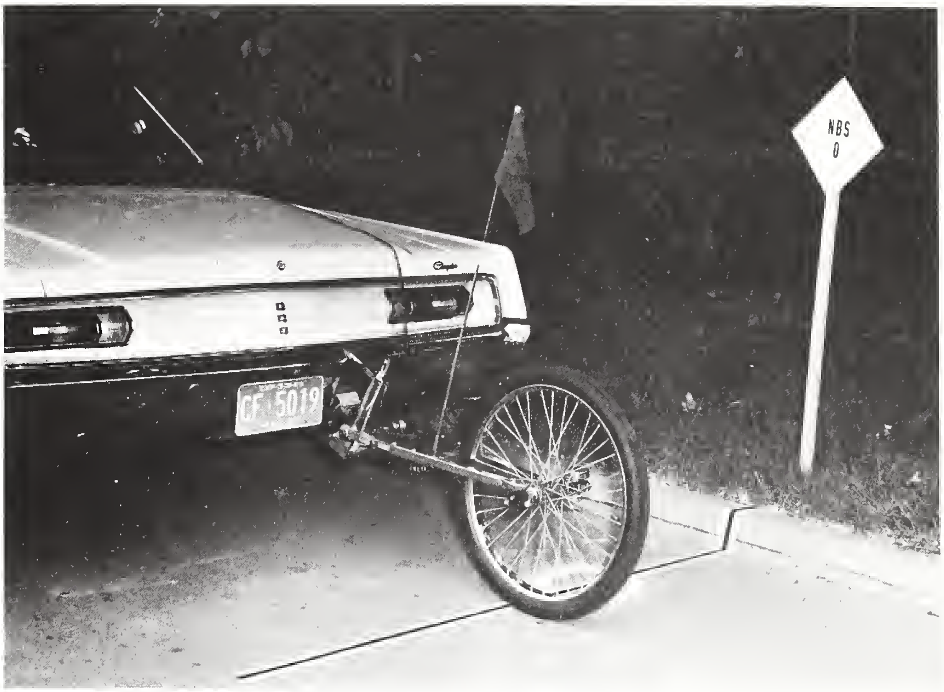


Figure 10. Fifth-wheel in calibration position on measured course.

If the electrical counting head of the fifth wheel is to be powered from the cigarette lighter socket, a connecting cable about 20 feet (6 m) in length should also be used. This cable is recommended to permit placing the counter close to the fifth wheel when adjusting for zero start position.

Step 1. Attach the fifth wheel to the rear bumper of a motor vehicle with the bumper clamp (and any auxiliary clamps if needed). Do not install the fifth wheel in a position where the exhaust gases of the vehicle blow directly on any part of the fifth wheel or its components (clamps, frame, rim, tire, or the electrical contactor). Make all necessary connections between the fifth wheel and the counting mechanism, which should be placed on the front seat or dash of the vehicle.

Step 2. With the fifth wheel in operating position, and at a tire pressure of 26 to 28 psi (180 to 190 kPa) drive for at least five miles [8 km] to develop a stabilized tire pressure. At the measured course, drive slowly past the starting marker until the fifth wheel is aligned as closely as possible with the marker (Fig. 10). The point of contact of the fifth wheel with the road should be less than 10 inches [0.2 m] from the starting line. (see Fig. 11). Stop and set parking brake.

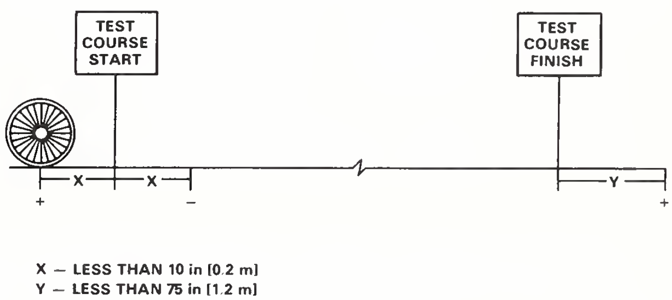


Figure 11. Determination of signs (plus + or minus -) and the limitations of alignment for start and finish of fifth-wheel calibrations.

(Department Heading)
Calibration Test Report of Fifth Wheel

Test No.____________ Date____________

Make of Fifth Wheel_______Serial No.______Tire Pressure (Fifth Wheel_____psi [kPa])
Length of Course________Where Tested________Avg. Temp._______Weather_______

Test Data	Run Numbers					
	1	2	3	4	5	Avg.
Temperature--						
1. Distance of fifth wheel from START marker---------						
2. Distance of fifth wheel beyond FINISH marker------ (This is always a PLUS value*)						
3. Total distance from markers (Item 1 plus Item 2)--						
4. Reading on Counter (to thousandth of a mile [km])						
5. Corrected reading (Item 4 minus 0.001 mile [km], if total distance (Item 3) equals or exceeds 31 11/16 inches [0.5 m]) --------------------------------						

*Distances should be indicated as plus, minus, or zero as indicated here:

Before + After - Beyond +

o————————————o

Measured Course

Start (within 10 inches [0.2 m] of starting mark)

Finish (first full counter indication beyond finish mark).

6. Over a measured course of _______miles [km]
   The calibration test indicates that the fifth wheel measures _______miles [km] (Item 5, Average)

7. Calibration correction (Item 6, minus Item 5, Average) and retain (+) or (-) sign. _______miles[km]

   If Item 6 is larger than Item 5, Average, the calibration correction is plus (+). If Item 5, Average, is larger than Item 6, the correction is minus (-).

________________ Inspector

________________ Title

Figure 12. A suggested fifth-wheel calibration report form.

Figure 13. Measuring distance from fifth wheel to starting point of measured course.

Figure 14. Synchronizing electrical contactor of fifth wheel with starting point of test.

Step 3. Adjust fifth wheel tire pressure to exactly 25 psi (170 kPa).

Step 4. Measure the distance the fifth wheel is from the starting point and record. (see Item 1, Fig. 12, Report Form.) The use of a plumb bob (Fig. 13) from the center point of the fifth wheel axle to the road surface will aid in measuring this distance. Give proper sign to value (plus or minus) as indicated in Figure 11. This measurement is zero if the fifth wheel is exactly aligned with the starting point.

Step 5. With the counter located in a viewable and audible position, lift the frame of the fifth wheel and freely rotate the tire in a forward direction for several clicks in the counter. With the wheel turning very slowly, stop the rotation the instant a full number clicks into place on the counter (Fig. 14) and lower the frame until the tire is in firm contact with the road surface. The wheel contactor is now synchronized with the starting point for the test. Place the counter in the vehicle in view of the driver and clear to zero.

Step 6. Accelerate without spinning wheels to 35 mi/h [55 km/h] and maintain this speed as constant as possible throughout the calibration run. Maintain a uniform distance between the vehicle and the road edge during the calibration run.

Step 7. As the final marker is approached, decelerate to a slow speed. Stop the vehicle the instant the counter registers the first whole number after the fifth wheel has passed beyond the final marker. Record on the Report Form, under Item 4, the counter indication.

Step 8. Measure the distance the fifth wheel has passed beyond the final marker (same method as Step 4) and record on Report Form, under Item 2. This distance should be less than 75 inches [1.2 m] and is always a plus value.

Step 9. Complete Report Form for Run 1.

Step 10. Continue making test runs until three complete runs are made. See completed Report Form Figure 15a for inch-pound units and Figure 15b for metric units. If there is more than 24 inches [0.6 m] difference between the total distances of individual runs review the calibration procedure. Some difficulty may be experienced in meeting this requirement if the rate of atmospheric temperature change exceeds 4 °F (2 °C) per hour.

Step 11. If the sum of total distances from the starting and finishing marks (Item 3, Report Form) equals or exceeds (a) for customary units, 31 11/16 inches or, (b) for metric units 0.5 m, subtract 0.001 mile or 0.001 km respectively, from the counter reading (Item 4, Report Form) to obtain the corrected counter reading (Item 5, Report Form). If Item 3 is less than 31 11/16 inches (customary) or 0.5 m (metric), the corrected counter reading is the same as Item 4 (the original counter reading).

Step 12. Obtain average corrected counter reading (Item 5, Average). This indicates the distance measured by the fifth wheel over the measured course.

Step 13. Complete the Report Form. As indicated on the Report Form, the calibration correction is obtained by subtracting the average corrected distance recorded by the fifth wheel (Item 5, Average) from the length of the measured course and retaining the proper + or - sign. If Item 6 is larger than Item 5 the calibration correction is plus (+). Conversely, if Item 5 is larger than Item 6 the correction is minus (-).

The fifth wheel appears to be slightly temperature sensitive. Changes of as much as 0.001 mile per mile per 20 °F or 0.001 km per km per 7 °C change in calibration temperature have been noted. Thus calibration should be made at approximately 30 °F [15 °C] intervals in the temperature of intended use. The temperature range of intended use should not be more than 20 °F [10 °C] from a calibration temperature. Keep copies of all calibrations with the fifth wheel when testing odometers and taximeters.

3.4. SIMULATED ROAD TEST EQUIPMENT.- The equipment listed below is directed solely to the simulated road test and is used in measuring distance by computation from rolling-circumference and wheel-turn data.

(Department Heading)
Calibration Test Report of Fifth Wheel

Test No. 3 Date 7/15/78

Make of Fifth Wheel AMW Serial No. 294 Tire Pressure (Fifth Wheel 25 psi)
Length of Course 1 mi. Where Tested Goshen Avg. Temp. 85°F Weather Sunny

Test Data	Run Numbers 1	2	3	4	5	Avg.
Temperature---------------------------------------°F	85	85	86			
1. Distance of fifth wheel from START marker--------in	+8	-2	+5			
2. Distance of fifth wheel beyond FINISH marker-----in (This is always a PLUS value*)	+39	+48	+47			
3. Total distance from markers (Item 1 plus Item 2)-in	+47	+46	+52			
4. Reading on Counter (to thousandth of a mile)------	1.000	1.000	1.000			
5. Corrected reading (Item 4 minus 0.001 mile), if total distance (Item 3) equals or exceeds 31 11/16 inches --	0.999	0.999	0.999			0.999

*Distances should be indicated as plus, minus, or zero as indicated here:

Before + After - Beyond +

o————————————o

Measured Course

Start (within 10 inches of starting mark)

Finish (first full counter indication beyond finish mark).

6. Over a measured course of 1.000 miles
The calibration test indicates that the fifth wheel measures 0.999 miles (Item 5, Average)

7. Calibration correction (Item 6, minus Item 5, Average) and retain (+) or (-) sign. +0.001 miles

If Item 6 is larger than Item 5, Average, the calibration correction is plus (+). If Item 5, Average, is larger than Item 6, the correction is minus (-).

Inspector

Title

Figure 15a. A completed fifth wheel calibration report form (inch-pound units).

(Department Heading)
Calibration Test Report of Fifth Wheel

Test No. 4 Date 6/17/79

Make of Fifth Wheel AMW Serial No. 294 Tire Pressure (Fifth Wheel 170 kPa)
Length of Course 2 km Where Tested Goshen Avg. Temp. 29 °C Weather Sunny

Test Data	Run Numbers 1	2	3	4	5	Avg.
Temperature--°C	29	29	29.5			
1. Distance of fifth wheel from START marker--------m	+0.20	+0.05	+0.12			
2. Distance of fifth wheel beyond FINISH marker-----m (This is always a PLUS value*)	+0.98	+1.20	+1.18			
3. Total distance from markers (Item 1 plus Item 2)-m	+1.18	+1.25	+1.30			
4. Reading on Counter (to thousandth of a km)-------	2.000	2.000	2.000			
5. Corrected reading (Item 4 minus 0.001, if total distance (Item 3) equals or exceeds 0.5m---km	1.999	1.999	1.999			1.999

*Distances should be indicated as plus, minus, or zero as indicated here:

Before + After - Beyond +

o————————————————o

Measured Course

Start (within 0.2 m of starting mark)

Finish (first full counter indication beyond finish mark).

6. Over a measured course of 2.000 km
The calibration test indicates that the fifth wheel measures 1.999 km
(Item 5, Average)

7. Calibration correction (Item 6, minus Item 5, Average) and retain (+) or (-) sign. +0.001 km

If Item 6 is larger than Item 5, Average, the calibration correction is plus (+). If Item 5, Average, is larger than Item 6, the correction is minus (-).

Inspector

Title

Figure 15b. A completed fifth-wheel calibration report form (metric units).

The following items in addition to those listed in Section 3 (Testing apparatus) are used in determining the rolling circumference:

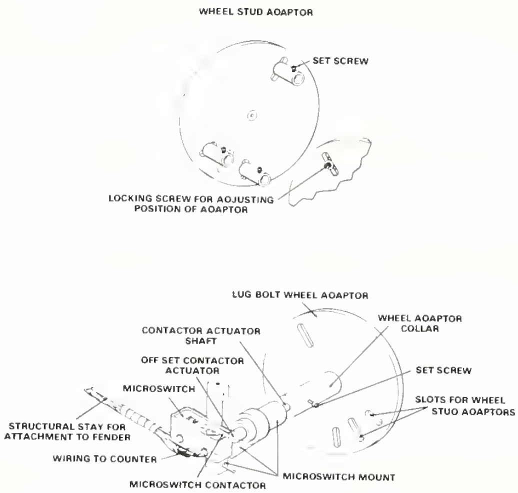
(a) Heavy-duty string;
(b) Stiff felt padding or weather stripping;
(c) White latex-base paint;
(d) Paint brush (1/2 inch or 1.2 cm);
(e) Screwdriver and scissors or knife;
(f) Two body jacks (2000 lb or 1000 kg capacity);

Counter systems using a pair of the following detectors are needed to count the wheel turns:

(a) electrical microswitch;
(b) magnetic microswitch;
(c) photodiode.

The counter systems consist of two basic parts, namely, the counters and the wheel-turn detectors. The counter for either the electrical or magnetic microswitch detectors is identical to the counter used with fifth-wheel testing equipment.

A schematic of a wheel-turn-detector assembly of the electrical microswitch type is illustrated in Figure 16. It consists of a microswitch, an offset contact actuator, a lug bolt wheel adaptor, wheel-stud adaptors, and a mount with a structural stay for attachment to the fender. The offset contact actuator operates the microswitch by the rotation of the wheel.



SCHEMATIC OF WHEEL-TURN-COUNTER

Figure 16. Wheel-turn-counter assembly.

The magnetic detector senses the wheel turns with a circuit containing a pair of magnetic reed switches. The reed switches respond to a magnet that is mounted on the side of the tire when the magnet in its path of rotation comes within 1/4 inch [6 mm] of the detector. A schematic of a magnetic-probe and counter assembly is given in Figure 17.

The photodiode detector senses the wheel turns with a photocell that picks up reflected light from a strip of self-adhesive white paper tape applied to the tire side wall. The probe is designed to provide illumination of the tape if there is insufficient ambient illumination available. In operation, the detector is placed within an inch or less of the path of rotation of the white paper tape. A schematic of a photodiode-probe and counting assembly is given in Figure 18.

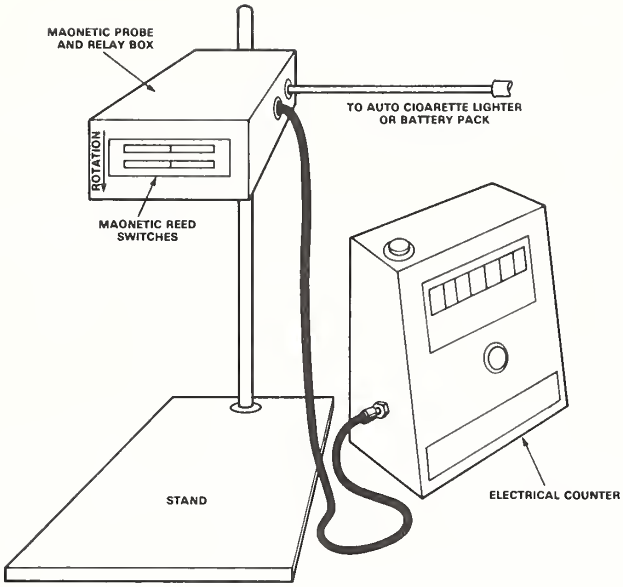


Figure 17. A schematic of a magnetic-probe and counter assembly.

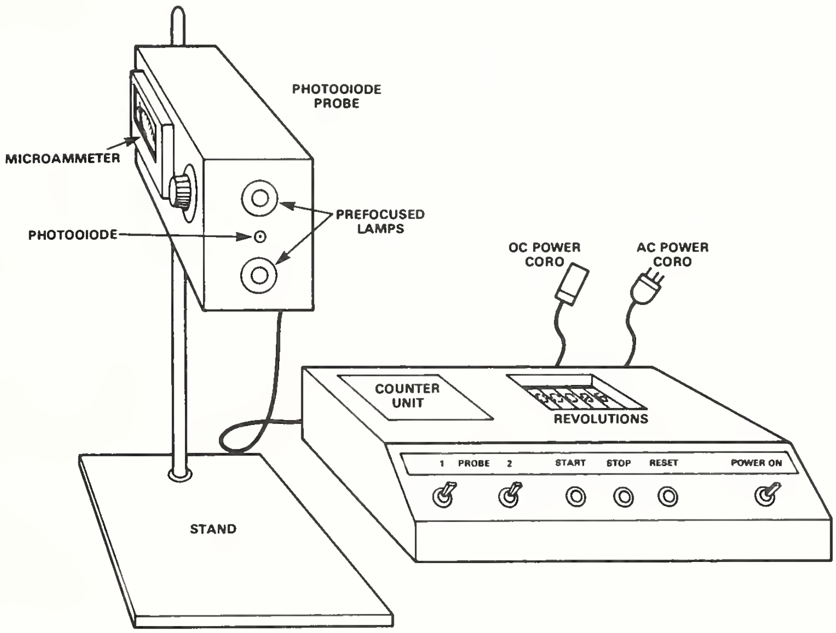


Figure 18. A schematic of a photodiode-probe and counter assembly.

A set of steel rolls with a ramp such as used with a dynamometer-type simulator may be used to place the odometer driving wheels in a position where they can turn freely while the vehicle under test remains stationary. An illustration of such rolls is given in Figure 19.

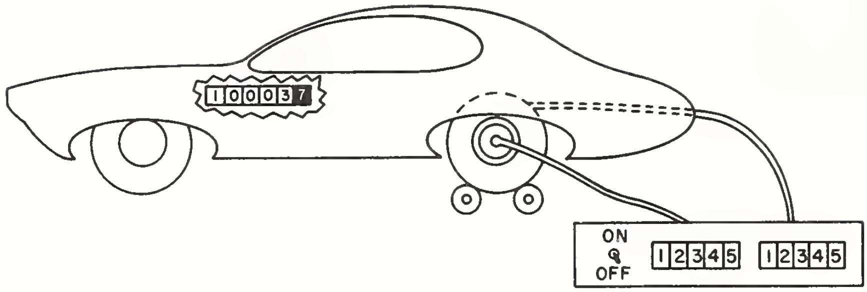


Figure 19. Wheel-turn-simulator rolls (used in conjunction with microswitch counting system).

4. INSPECTION OF COMMERCIAL DEVICES

For a discussion of the purposes and scope of "inspection", as distinguished from "testing", see Section 4 of Fundamental Considerations of Handbook 44.[1]

4.1. TAXIMETERS.- Individual taximeters and taximeter installations should be inspected for compliance with applicable requirements of the general code and the taximeter code of Handbook 44.[1] The inspection should precede testing. Some inspection items are proper device identifications, the position and illumination of the taximeter, visibility of indications, security seals, and fare identification. There should also be identification of "extras" if used. If "extras" are not permitted and there is provision for them on the taximeter the relevant mechanism should be made inoperable or the "extras" indication should be permanently obscured.

The taximeter should be checked to verify that the positions of operation are properly defined. This check should include a number of operations designed to determine that certain parts of the meter are functioning properly and that any shutters and shields operate as they should. The clearing of the taximeter should be checked when returned to the "vacant" or "for hire" position. The fare and "extras" indications should be protected by glass or other suitable transparent material and be centered in their apertures. When the taximeter is operated in the "time not recording" position either the clock should not be operating or its operation should not cause any fare registration. Electronic taximeters should be checked to see that their operation is not affected in any way by radio frequency interference. Since most taxicabs are equipped with two-way radios, these can be used in conducting the test, or a conventional two-way citizens band (CB) radio may be used. One should also observe the operation of the taximeter when various accessory switches of the vehicle are operated and when the vehicle is in the vicinity of power transmission lines and heavily industrialized areas.

A statement of rates for distance and time (and schedule of "extras" when the use of an "extras" mechanism is sanctioned) should be of a permanent material or be protected by glass or other suitable transparent material.

The operating tire pressure of the vehicle tires should be the operating tire pressure posted in the vehicle.

4.2. ODOMETERS.- Odometers should be inspected for compliance with the applicable codes of Handbook 44.[1] The indicating element should be clean and easily read. Any protective covering should also be clean and not detract from the readability of the indications. Ideally, the odometer indications should be capable of advancement only by rotation of the odometer driving wheel (or wheels), regardless of direction of rotation. Most odometers, however, advance only when the odometer driving wheel or wheels are turned in a forward direction and remain stationary when turned in a rearward direction.

The operating tire pressure of the vehicle tires should be the operating tire pressure posted in the vehicle.

5. PREPARATION AND TESTING OF COMMERCIAL DEVICES

The preparation and testing of commercial devices section is divided into two subsections, namely, taximeter and odometers. The test requirements for the two devices are different. The test procedures, while similar in some respects (such as test equipment), are sufficiently different to warrant separate subsections.

5.1. TAXIMETERS.- Note: The Notes and Tolerances Sections of the Taximeter Code in Handbook 44[1] is the basis for the test requirements. However, the Handbook is subject to change on a yearly basis. The test requirements are given in this Handbook primarily as a guide to the inspector. It is the inspector's responsibility to ascertain if any changes have been made in the test requirements since the publication of the 1980 Edition of the Handbook.

Handbook 44[1] in its test requirements specifies that the distance test of a taximeter shall be made utilizing a (1) road test, (2) fifth-wheel test, or (3) simulated road test. The distance test of a taximeter, whether a road test, a simulated-road test, or a fifth-wheel test, includes at least duplicate runs of sufficient length to cover at least the third money drop or one mile, whichever is greater, and is conducted at a speed approximating the average speed traveled by the vehicle in normal service. During the distance test, the vehicle shall carry two persons or, in the case of a simulated-road test, 150 pounds (70 kg) of test weights may be substituted in lieu of the second person. At the completion of the test run or runs, the tires that drive the taximeter of the vehicle under test must be checked to determine that the tire pressure is that operating tire pressure posted in the vehicle. If not, the tire pressure must be adjusted to the posted tire pressure before additional tests are made. If a taximeter is equipped with a mechanism through which charges are made for time intervals, the mechanism is tested at least through the first 5 time intervals or money drops. In addition, a test shall be conducted to determine whether there is interference between the time and distance mechanisms. During the interference test, the vehicle is operated at a speed of 2 or 3 miles per hour [3 or 4 km/h] faster than the speed at which the basic distance rate equals the basic time rate. The determination of this speed is given in 5.1.1.2.

The tolerances on taximeters are given in Handbook 44[1] and are reviewed here for the convenience of the reader.

The maintenance and acceptance distance tolerances for taximeters are:

On overregistration, 1 percent of the interval under test.

On underregistration, the tolerances are 4 percent of the interval under test, with an added tolerance of 100 feet [30 m] whenever the initial interval is included in the interval under test.

The maintenance and acceptance tolerances on individual time intervals are:

On overregistration, 3 seconds per minute (5 percent).

On underregistration, the tolerances are 9 seconds per minute (15 percent) on the initial interval, and 6 seconds per minute (10 percent) on other intervals.

The maintenance and acceptance tolerances on the average time interval excluding the initial interval are:

3 seconds per minute (5 percent) on underregistration.

No tolerance is allowed on overregistration for the average time interval.

NOTE: Tolerances quoted here refer to NBS H-44-1980 Edition and may not be current.

The preparation and testing of taximeters is divided into three procedures. The first procedure is a test procedure common to all test methods. The other two procedures are concerned with specific distance-device-evaluation procedures, namely, the measured-course and the fifth-wheel test. Because of its complexity, the simulated road test procedure is not recommended for testing taximeters.

5.1.1. DESIGNS AND TEST PROCEDURES COMMON TO ALL METHODS.- This section is concerned with the design of time-interval and interference tests and with the time-interval test procedures. These would be the same regardless of the distance-evaluation procedure employed.

5.1.1.1. DESIGN OF TIME-INTERVAL AND INTERFERENCE TESTS.- The design of time-interval and interference tests is dependent upon the code requirements of Handbook 44[1] and information provided in the statement of rates, namely; the hourly rate, and the charge and distance for the initial and subsequent drops. The inspector should be familiar with the use of this information to develop applicable test criteria and tolerance tables.

5.1.1.1.1. THE TIME-INTERVAL TEST.- A chart or table tailored to Handbook 44 tolerances for individual and average time intervals as applied to local or state taximeter rates for time and distance should be prepared before conducting this test. An example of such a table is given in Table 1. In the development of this table assumptions were made concerning the basic waiting time and distance rates and the initial money drop for a specified unit of distance in order to develop a table with tolerance ranges in actual units of time. The rates, may vary with the different jurisdictions, thus requiring that each jurisdiction develop its own table of tolerance ranges on time-interval tests.

Tolerance Range On Time-Interval Tests[1]

Waiting-Time Rate: $8 per hour in addition to premium[a]

Distance Rate: $0.50 per first 1/5 mile, $0.20 per subsequent 1/5 mile

Money Drop	Fare (dollars)	Time	
		Calculated	Tolerances Range
Flag	0.50		
1	0.70	1 min 30 s	1 min 25.5 s to 1 min 43.5 s (initial time interval)
2,3,4 5,etc.	0.90,1.10 1.30,etc.	1 min 30 s	1 min 25.5 s to 1 min 39 s (other individual time intervals)
2,3,4, 5, etc.	0.90,1.10 1.30,etc.	1 min 30 s	1 min 30 s to 1 min 34.5 s (average of other individual time intervals

[a]See 5.1.1.1. concerning premium included in the initial money drop.

Table 1. Sample table of tolerance range on time-interval tests.

Usually, the initial interval that starts with the flag or initial money drop includes, in addition to the fare charge on a time and a distance unit basis as in subsequent intervals, a premium charge. For example, in Table 1 the time or distance provided in the initial interval is the same as provided in subsequent intervals but the fare for the initial interval is 50 cents and the fare for subsequent intervals is 20 cents. Thus, the premium charge for the initial interval is 30 cents and is not based on time and/or distance.

The time interval per subsequent drop may be determined as follows:

$$\underset{\text{(min)}}{\text{Subsequent time interval}} = \frac{\text{60 x charge per money drop (excluding initial drop)}}{\text{Hourly charge (basic time rate)}}$$

where the charge per subsequent drop is usually posted in terms of a fare charge for a distance interval.

This formula gives the time interval in minutes and decimal fractions of a minute. To convert to minutes and seconds, the decimal fraction should be multiplied by 60. The following example illustrates how the subsequent time interval is determined.

Assume:

Basic time rate = \$8/h

Charge per money drop = \$0.20

$$\text{Subsequent Time Interval} = \frac{60 \times 0.20}{8.00} = 1.5 \text{ min} = 1 \text{ min} + 0.50 \times 60 \text{ s} = 1 \text{ min } 30 \text{ s}$$

The time interval for the initial drop may be determined as follows:

$$\text{Initial time interval} = \frac{\text{Initial Drop Distance} \times \text{Subsequent Drop Time}}{\text{Subsequent Drop Distance}}$$

where the charge per initial drop is usually posted in terms of a fare charge for a distance interval.

This formula also gives the time interval in minutes and decimal fractions of a minute and the appropriate conversion to minutes and seconds may be made. The following example illustrates how the time interval is determined.

Assume:

Distance per initial drop = 1/5 mile
Distance per subsequent drop = 1/5 mile
Time per subsequent drop = 1.5 min
(in decimal minutes)

$$\text{Initial Time Interval} = \frac{1/5 \times 1.5}{1/5} = 1.5 \text{ min} = 1 \text{ min } 30 \text{ s}$$

5.1.1.1.2. THE INTERFERENCE TEST.- When interference between the time and distance mechanisms does occur it is usually detected at taxicab speeds 2 or 3 miles per hour above the changeover speed (the speed at which the fare computed using the basic distance rate is in agreement with the fare computed using the basic time rate). This speed can be determined in the following manner:

$$\text{Changeover speed (distance per hour)} = \frac{\text{Hourly charge}}{\text{(basic time rate)}} \times \frac{\text{Distance per money drop}}{\text{Charge per money drop}^{a}}$$

The following example shows how this speed is determined:

Assume:

Basic time rate = \$8.00 per hour
Distance per money drop = 1/5 mile = 0.2 mile
Charge per money drop = \$0.20

$$\text{Speed (mph)} = 8.00 \times \frac{0.2}{0.20} = 8 \text{ mph}$$

The interference test is made at the conclusion of the distance tests, and is included with the distance tests (Sections 5.1.2.2. and 5.1.3.2.).

5.1.1.2. THE TIME-INTERVAL TESTS.- A taximeter equipped with a mechanism through which charges are made for time should be tested through at least the first 5 time intervals with respect to the individual time intervals and the average time intervals (excluding the initial

[a] Excluding initial money drop.

interval). The tests are made with a calibrated stopwatch or timer. Stopwatch or timer calibration is discussed in Section 3.1.

Step 1. Put the taximeter into the "hired position" and simultaneously start the stopwatch or timer.

Step 2. Observe and record the elapsed time to the nearest second on the stopwatch or timer at the instant when the next money drop occurs.

Step 3. Repeat Step 2 for at least 4 or more money drops.

Step 4. On the final money drop, stop the stopwatch or timer at the instant when the money drop occurs.

Step 5. Read and record the elapsed time to at least the nearest second.

5.1.2. TEST PROCEDURE USING A MEASURED COURSE.- This taximeter test procedure is concerned with the use of the road test method. Other examination and test procedures related to taximeters are discussed in Section 5.1.1. which is devoted to examination and test procedures for taximeters that are common to all test methods.

5.1.2.1. DESIGN AND LAYOUT OF A MEASURED COURSE.- A chart or table based on Handbook 44 tolerances for distance as applied to local or state taximeter rates should be prepared before laying out a measured course. An example of such a table in inch-pound units is given in Table 2. The parameters involved in preparation of the table are the taximeter tolerances, the unit of distance alloted to the initial drop, the distance alloted to subsequent drops, and, the initial and subsequent drop fares. In the development of this table, assumptions were made concerning the basic distance rate and the initial drop for a specified unit of distance. The rates, of course, will vary among the different jurisdictions, requiring that each jurisdiction develop its own table of tolerance limit distances for money (fare) drops and distance.

Money Drop	Distance	Fare	Overregistration Tolerance Limit (1% of distance)	Money Drop Distance	Underregistration Tolerance Limit (4% of distance + 100 ft.)
	miles	dollars	ft	ft	ft
Initial	0	.50			
1	1/5	.70	1045.4	1056	1198.2
2	2/5	.90	2090.9	2112	2296.5
3	3/5	1.10	3136.3	3168	3394.7
4	4/5	1.30	4181.8	4224	4493.0
5	1	1.50	5227.2	5280	5591.2

Distance Rate: $0.50 per first 1/5 mile, $0.20 per subsequent 1/5 mile.

Table 2. A sample table of tolerance limit distances (in feet) as compared to money (fare) drops and distance

The length of the test course is determined by test requirements given in Handbook 44[1] and the Statement of Rates. Thus, if the initial and subsequent distance drops in inch-pound units are 1/5 mile, the test course must be one mile long since it must be of sufficient length to cover at least the third money drop or one mile, whichever is greater. In metric units, if the initial and subsequent distance drops are 1/2 kilometer, the test course must be two kilometers since it must be of sufficient length to cover at least the third money drop or two kilometers, whichever is greater.

A table prepared using metric units is given as an example in Table 3.

Money Drop	Distance	Fare	Overregistration Tolerance Limit (1% of distance)	Money Drop Distance	Underregistration Tolerance Limit (4% of distance +0.03 km)
	km	dollars	km	km	km
Initial	0	0.60			
1	1/2	0.90	0.495	0.500	0.550
2	1	1.20	0.990	1.000	1.070
3	1 1/2	1.50	1.485	1.500	1.590
4	2	1.80	1.980	2.000	2.110

Distance Rate: $0.60 per first 1/2 km, $0.30 per subsequent 1/2 km

Table 3. A sample table of tolerance limit distances as compared to money (fare) drops and distance in metric units

Schematic layouts of the test courses as developed in Tables 2 and 3 are given in Figures 20 and 21, respectively. For efficient use of time and distance the layout described in this Handbook is designed to permit testing in both directions on the course. The test course may be laid out as described in Section 3.3.2.1. and/or with a calibrated fifth wheel. If a calibrated fifth wheel is used, a layout of the test course as developed in Table 4 is used. The uncertainty in the measured course should not exceed 0.1%. Markers should be placed along the side of the road or on the divider strip to indicate the starting position, money-drop-distances, and overregistration and underregistration tolerance limits. The markers should be appropriately labeled. One method of marking is indicated in Figure 22. Color coding the markers for (a) start and money drop distance (b) overregistration tolerance limit, and (c) underregistration tolerance limit will be useful.

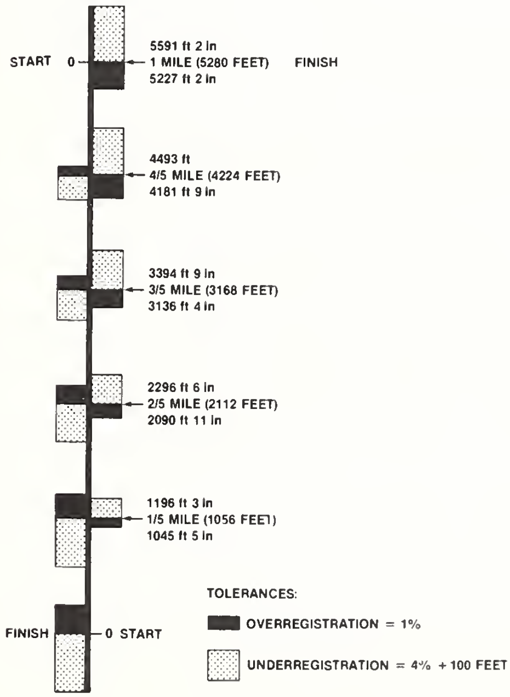


Figure 20. A schematic layout of a test course (based on Table 2).

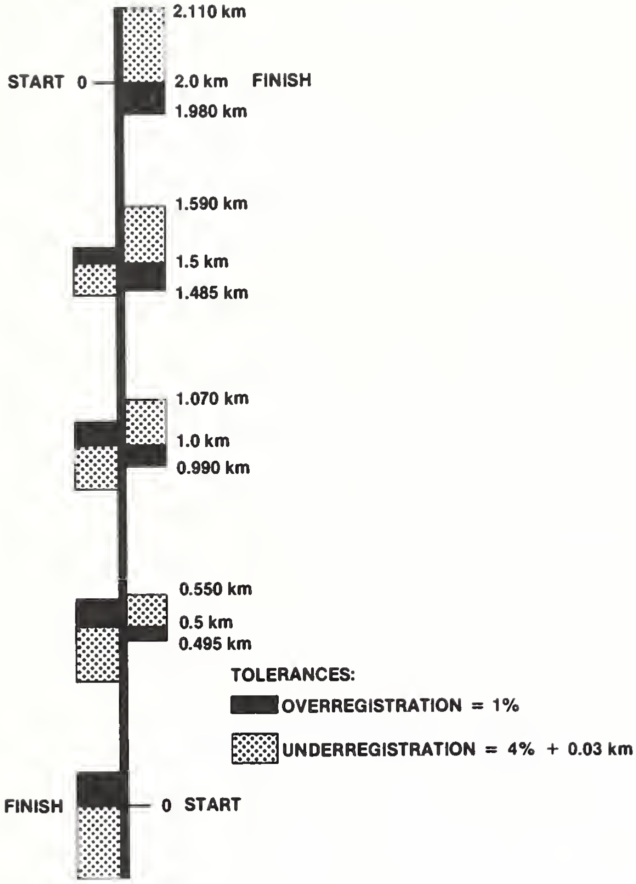


Figure 21. A schematic layout of a metric test course (based on Table 3).

Money Drop	Distance	Fare	Overregistration Tolerance Limit (1% of distance)	Money Drop Distance	Underregistration Tolerance Limit (4% of distance + 100 feet)
	miles	dollars	miles	miles	miles
Flag	0	.50			
1	1/5	.70	.198	.200	.227
2	2/5	.90	.396	.400	.435
3	3/5	1.10	.594	.600	.643
4	4/5	1.30	.792	.800	.851
5	1	1.50	.990	1.000	1.059

Distance Rate: $0.50 per first 1/5 mile, $0.20 per subseqest 1/5 mile

Table 4. A sample of tolerance limit distances in decimal miles as compared to money (fare) drops and distance

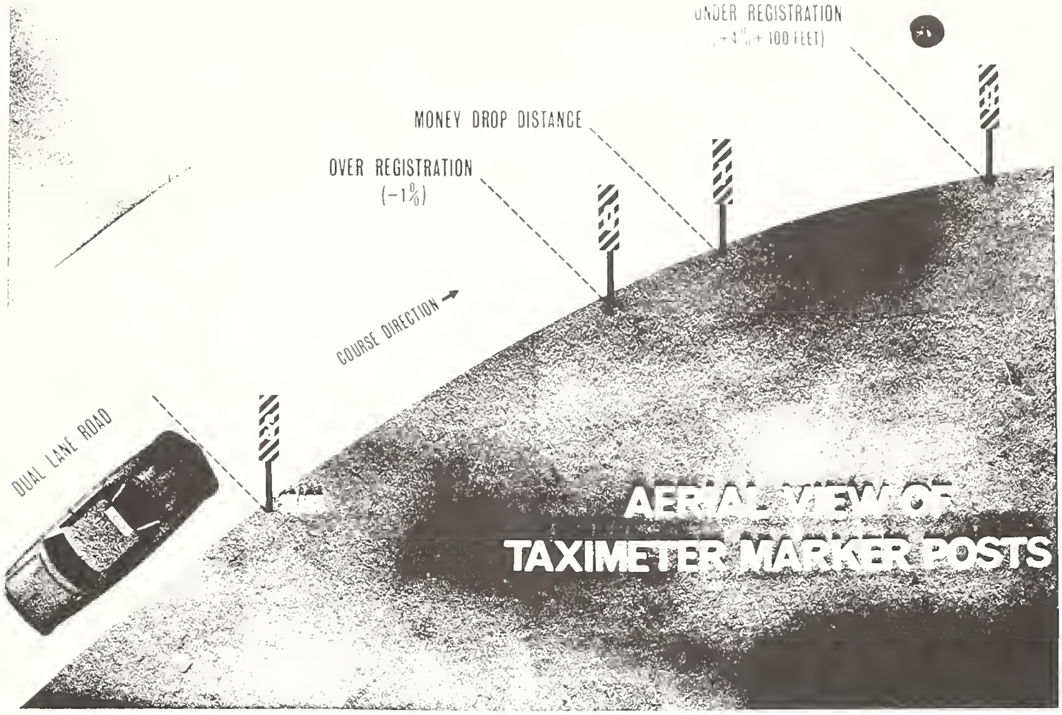


Figure 22. An aerial view of the taximeter marker posts.

5.1.2.2. THE DISTANCE AND INTERFERENCE TESTS.- The taximeter code in Handbook 44[1] specifies that the distance test must include at least duplicate runs at a speed approximating the average speed traveled by the vehicle in normal service. A vehicle loading of two persons and a stabilized tire pressure[1] are also specified.

The inspector should always have the taxicab driver operate the vehicle during these tests. This leaves the inspector free to make all the necessary observations and record the test data. He should sit in the front seat alongside the driver where he can observe the taximeter under test to detect effects of road shocks or radiofrequency interference on the mechanism, or any abnormality in the operation of the indicating elements.

The four-way hazard-warning signals of the vehicle under test should be operating whenever a test is being conducted.

Step 1. Have the test vehicle move into the starting position. Set the taximeter in the "time not recording" position. This insures that the clock mechanism will not affect the meter registration should it become necessary to slow down or stop the vehicle.

Step 2. Accelerate wheels without spinning to a speed approximating average normal service. This is generally 20-30 mph [35-50 km/h].

Step 3. Have the driver drive the vehicle over the course in a straight line as nearly as possible. Check the money drops "on the fly" and stop for the last money drop. In checking the money drops "on the fly" the inspector need only verify that the taxicab is within the overregistration and underregistration tolerance limits for the particular drop. Check the taximeter for sticking of money drops, improper sequence of money drops, poor alignment of indications, visibility of indications and other abnormal conditions, such as premature money drops which may occur as a result of road shocks or radio -frequency interference. If the taximeter appears to be close to or out of tolerance, the inspector has the option to have the vehicle slow down and stop at each money drop to permit a more accurate determination of error. He may wish to measure the distance with respect to the tolerance marker if he chooses. At the completion of the test run check the tire pressure of the tires on the wheels that drive the taximeter. If the tire pressure is not that operating tire pressure posted in the vehicle and prosecution is contemplated because of an out-of-tolerance condition make additional test runs as desired before continuing with test. Otherwise, adjust to the posted tire pressure, record all test data, and continue with Step 4.

Step 4. Repeat the test run (Steps 1 through 3) in the opposite direction.

Step 5. Start an interference test run with taximeter still in the "time not recording" position and immediately accelerate vehicle (without spinning wheels) to a speeed 2 to 3 mph [3 to 5 km/h] greater than the changeover speed. The procedure for determining this speed is described in 5.1.1.1.2.) Immediately at this test speed set the taximeter into the "hired" position. During the test this test speed should be maintained and the vehicle should not be stopped or slowed down below the speed of rate agreement. If a stop or slow down is unavoidable for safety or other reasons, the test should be repeated. If the vehicle is to be stopped at the final test drop, set the taximeter into the "time not recording" position before the speed drops down to the changeover speed. The results of both the interference and distance tests shall be within distance tolerances and the difference between the two tests must not be greater than 1 percent.

Step 6. Recheck pressure of tires discussed in Step 3. If the tire pressure has changed more than 1 psi (7 kPa) in either direction repeat the tests. Additional test runs may be made as considered necessary.

5.1.3. TEST PROCEDURE USING FIFTH-WHEEL TESTING EQUIPMENT.- This taximeter test procedure details the use of the fifth-wheel. Information on the design of a fifth-wheel device including illustrations and suggested general specifications and a calibration procedure are given in Section 3.3.

Other examination and test procedures for taximeters common to all test methods are given in Section 5.1.1.

5.1.3.1. TEST DESIGN AND TEST SITE SELECTION.- A chart or table based on Handbook 44 tolerances for distance as applied to local or state taximeter rates should be prepared before conducting fifth-wheel tests of a taximeter system. A sample table for distance in inch-pound units is given in Table 4. A similar table in metric units is given in Table 3. Other considerations common to the measured course and fifth wheel procedures are discussed in Section 5.1.2.1.

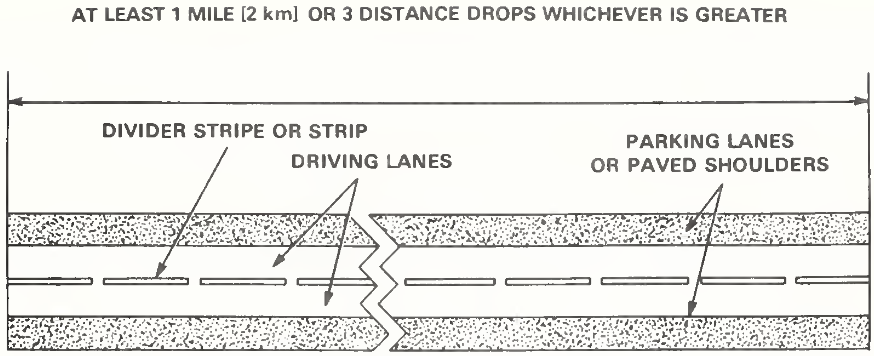
A schematic drawing of a proposed test site is given in Figure 23. It should have a speed limit of at least 25 miles per hour [40 km/h] and be free of traffic interference and traffic control devices. In addition, a paved shoulder or parking lane should be available where the test vehicle and attached fifth wheel may be temporarily parked, started for distance tests, and stopped at the conclusion of the run. The road crown should not exceed two percent. In the interest of safety, every consideration should be given to a test site having good visibility. To save time the test site should be usable in both directions.

5.1.3.2. THE DISTANCE AND INTERFERENCE TESTS.- Some considerations common to the measured course and fifth wheel procedures are discussed in the first three paragraphs of Section 5.1.2.2.

Attach the fifth wheel to the rear bumper of the test vehicle observing precautions and considerations as discussed in the first paragraph and Step 1 of 3.3.2.2.

The test procedure is the same as that described in 5.1.2.2. except that the fifth-wheel counter is cleared prior to the start of the test run in Step 1 and a table such as Table 4 is used to provide underregistration and overregistration tolerance limits in Step 3.

5.2. ODOMETERS.- Handbook 44[1] in its test requirements specifies that the distance test of an odometer must be made utilizing a (1) road test, (2) fifth-wheel test, or (3) simulated road test. These are described in Section 2.



SPEED LIMIT: AT LEAST 25 MILES PER HOUR [40 km/h]
NO STOP SIGNS OR TRAFFIC LIGHTS
REASONABLY STRAIGHT WITH NO SHARP TURNS
GOOD VISIBILITY
PARKING LANE OR PAVED SHOULDER
AT LEAST IN THE STARTING ZONE

Figure 23. A suitable test site for taximeter testing.

The distance test of an odometer, whether a road test, a simulated road test, or a fifth-wheel test, must include at least two runs two miles [3 km] in length. The test runs shall start from and finish at a dead stop with a minimum of 80 percent of the run between 30 and 45 miles per hour [50 to 70 km/h]. The four-way hazard warning signals of the vehicle under test should be operating whenever a test is being conducted. During the distance test, a passenger vehicle may carry two persons and a truck must be loaded with one-half of the maximum cargo load. A stabilized tire pressure[1] is also specified.

The precision or repeatability of odometer test runs is dependent on how well the orientation of the 1/10 mile [0.1 km] indication observed before the run is duplicated at the end of the run. The inspector should hold his head and eyes in the same position relative to the odometer to eliminate the possibility of error caused by parallax.

The maintenance and acceptance distance tolerances for odometers are 4 percent of the interval under test and are applied to errors of underregistration and overregistration.

Regardless of the test procedure used, the following information should be recorded: date, test number, vehicle number, address, make, year, model, body style, serial number, license number, and identification number of vehicle under test. Also record the make, style, ply, and size of the tires driving the odometer. Where the measured course or fifth-wheel test method is used, also note the ambient temperature and road condition.

While the test procedures that follow are oriented toward passenger vehicles they are equally applicable to trucks as defined in H-44.[1]

5.2.1. TEST PROCEDURE USING A MEASURED COURSE.

5.2.1.1. DESIGN AND LAYOUT OF MEASURED COURSE.- A measured course for an odometer test may be laid out as outlined in Section 3.3.2.1. and/or with a calibrated fifth wheel. It should be noted, however, that the course is two miles [3 km] in length. The uncertainty in the measured course should not exceed 0.1 percent. A schematic layout of a measured course for odometer testing is given in Figure 24. The layout is designed to permit testing in both directions on the course to reduce test time and distance traveled with no traffic congestion or traffic control devices and a speed limit of at least 30 miles per hour [50 km/h]. A four-lane or divided road with a paved shoulder is preferred. Good visibility and minimum of hazards to personnel and traffic should serve as a guide to the selection of a test site. All starting lines and finish zone markers (percentage error and two-mile tolerances) should be marked off on the paved shoulder of the road. Markers should be placed alongside the shoulder of the road to indicate the starting position, the two-mile point, and the overregistration and underregistration tolerance limits.

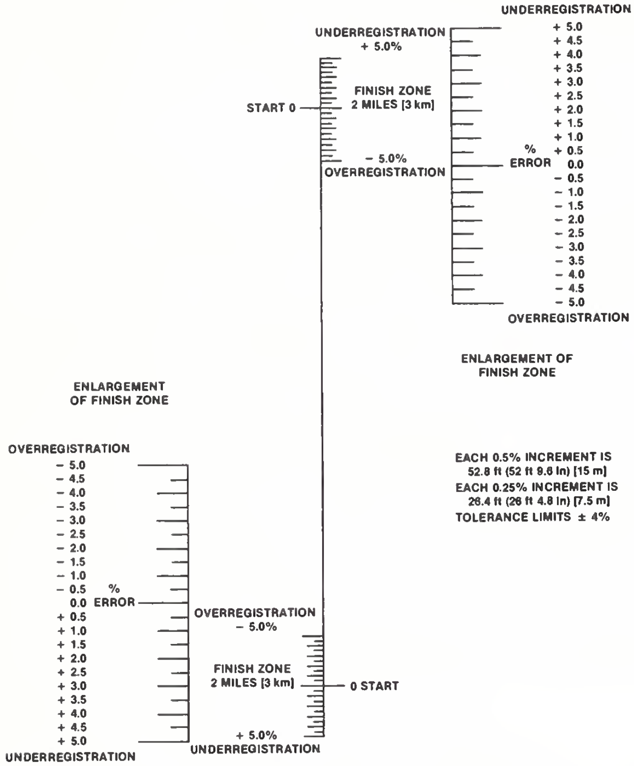


Figure 24. A schematic layout of a measured course for odometer testing.

5.2.1.2. THE DISTANCE TESTS.- Steps 1 through 6 are a screening procedure designed to permit rapid evaluation of a group of vehicles to determine if a problem exists. Because of the larger uncertainty involved it is not designed to serve as a possible violation procedure. Steps 7 through 12 and other odometer test procedures are designed as possible violation procedures.

Step 1. Align front bumper (or any part of vehicle) with the starting line of measured course. Observe and record odometer reading and reproduce orientation of 1/10 mile [0.1 km] indication in odometer window from a predetermined viewing position to eliminate error due to parallax as shown in Figure 25.

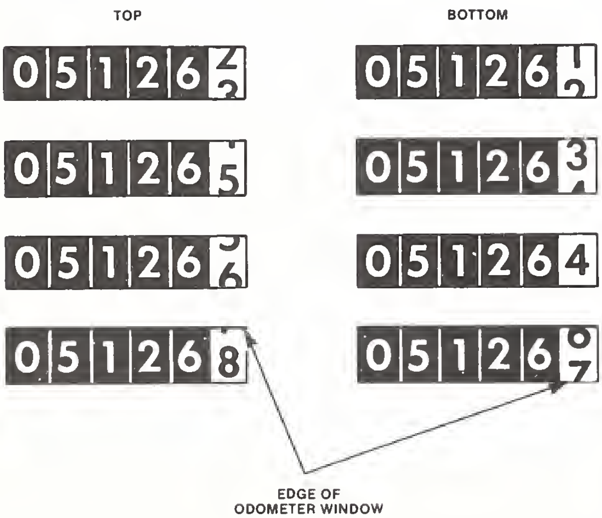


Figure 25. Some random orientations of 1/10 mile [0.1 km] indications in odometer window for the measured course screening test.

Step 2. Accelerate the vehicle without spinning the wheels to 30 to 45 mph [50 to 70 km/h]. Maintain the speed until ready to decelerate, without skidding to complete the two-mile run on the odometer. The orientation of the 1/10 mile [0.1 km] indication should be exactly the same as at the start of the test.

Step 3. Record the odometer reading.

Step 4. Note and record the location of the front bumper (or other reference point selected in Step 1) with respect to the closest percent error indication in the finish zone (see Figure 24).

Step 5. At the completion of the test run check the tire pressure of the tires on the wheels that drive the odometer. If the tire pressure is not that operating tire pressure posted in the vehicle and prosecution is contemplated because of an out-of-tolerance condition, make additional test runs as desired, adjust to posted tire pressure and continue with Step 6.

Step 6. Repeat the test run in the opposite direction. Recheck the tire pressure. If the tire pressure has changed more than 1 psi (7 kPa) in either direction, repeat the test. If the error of the test run or runs at the posted tire pressure exceeds ±3 percent, continue with Step 7.

Step 7. Align front bumper or other vehicle part with the starting line in the same manner as Step 1. With the aid of a jack (scissors or hydraulic) raise one odometer driving wheel (two odometer driving wheels if connected to a limited slip differential) off of the road. (A method of determining whether a vehicle has a limited slip differential is presented in Step 1 of the second wheel turn counting procedure presented in 5.2.3.2.2.) While observing the odometer from the predetermined viewing position, drive the raised wheel or wheels until the horizontal bar of the numeral 2, 4, 5, or 7 of the 1/10 mile [0.1 km] indicator is lined up with the top or bottom of the odometer window and stop. The precision or repeatability of the test run is dependent on how well this orientation is duplicated at the end of the run. The position of the selected numeral of the 1/10 mile [0.1 km] indicator (see Figure 26) can be most easily reproduced if aligned closely to the upper or lower edge of the odometer window. Record odometer reading and reproduce 1/10 mile [0.1 km] indication on odometer. Lower odometer driving wheel or wheels, remove jack or jacks, and place jacks in vehicle.

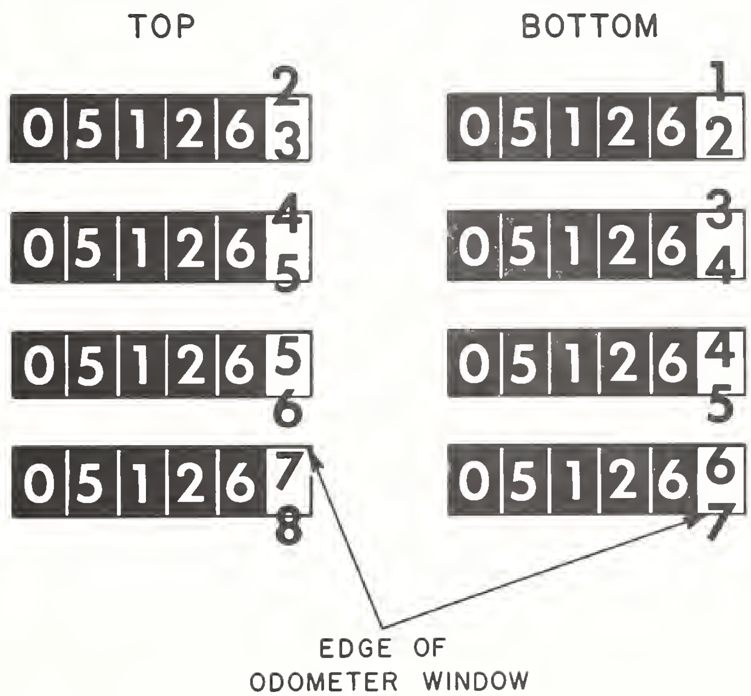


Figure 26. Alignment of numbers of 1/10 mile [0.1 km] indicator.

Step 8. Accelerate to 30 to 45 mph [50 to 70 km/h] without spinning wheels. Maintain this speed until ready to decelerate, without skidding, to complete a two-mile [3-km] run on the odometer such that the 1/10 mile [0.1 km] indicator is in exactly the same position as at the start of the test.

Step 9. Record the odometer reading.

Step 10. Note and record the location of the front bumper (or other reference point selected in Step 1) with respect to the closest percent error indication in the finish zone.

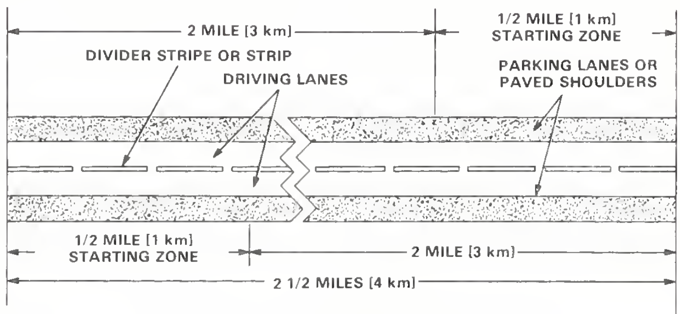
Step 11. Recheck the vehicle tire pressure.

Step 12. Repeat the test run (Step 7 on) in the opposite direction.

5.2.2. TEST PROCEDURE USING FIFTH-WHEEL TESTING EQUIPMENT - Information on the design of fifth-wheel testing equipment including illustrations and suggested general specifications and a calibration procedure are given in Section 3.3.

5.2.2.1. TEST DESIGN AND TEST SITE SELECTION.- The test consists of two test runs of at least two miles [3 km] each with provision for aligning the odometer in an easily reproducible position for greater accuracy and precision. Safety should be a prime consideration in the test design.

The test route selected (Figure 27) should be at least 2 1/2 miles [4 km] long (to provide a half mile [1 km] starting zone).



SPEED LIMIT: AT LEAST 30 MILES PER HOUR [50 km/h]
NO STOP SIGNS OR TRAFFIC LIGHTS
REASONABLY STRAIGHT WITH NO SHARP TURNS
GOOD VISIBILITY
PARKING LANE OR PAVED SHOULDER AT LEAST IN THE STARTING ZONE

Figure 27. A suitable test site for odometer testing.

5.2.2.2. THE DISTANCE TESTS.- Attach the fifth-wheel to the rear bumper of the test vehicle observing precautions and considerations as discussed in the first two paragraphs and Step 1 of 3.3.2.2.

Step 1. Inflate the fifth-wheel tire to 28 psi (190 kPa). Stabilize test vehicle and fifth-wheel tires with a run of at least five miles [8 km].

Step 2. Drive slowly in the starting zone of the test course until the horizontal bar of the numeral 2, 4, 5, or 7 of the 1/10 mile [0.1 km] indicator is lined up with the top or bottom of the odometer window and stop. The position of the selected numeral of the 1/10 mile [0.1 km] indicator (see Figure 26) can be most easily reproduced if aligned closely to the upper or lower edge of the window of the window of the odometer.

Step 3. Record odometer reading and reset fifth-wheel counter to zero.

Step 4. Adjust fifth-wheel tire pressure to 25 psi (170 kPa).

Step 5. Accelerate to 30 to 45 mph [50 to 70 km/h] without spinning wheels. Maintain speed until ready to decelerate, without skidding, to complete two mile [3 km] run on odometer such that the 1/10 mile [0.1 km] indicator is in exactly the same position as at the start of the test.

Step 6. Record odometer reading.

Step 7. Record fifth-wheel counter reading. If counter is not at a full number "click," record the highest full number in view.

Step 8. At the completion of the test run check the tire pressure of the tires of the wheels that drive the odometer. If the tire pressure is not that operating tire pressure posted in the vehicle and prosecution is contemplated because of an out-of-tolerance condition make additional test runs as desired. Otherwise adjust to the posted tire pressure.

Step 9. Repeat test run (Steps 1 through 8) in the opposite direction. If the tire pressure has changed more than 1 psi (7 kPa) in either direction, repeat the test.

5.2.3. TEST PROCEDURE USING A SIMULATED ROAD TEST.- Information on equipment needs for simulated road tests is given in Section 3.4.

5.2.3.1. TEST DESIGN AND TEST SITE SELECTION.- This procedure determines (1) the rolling circumference of the tires on the wheels that drive the odometer of the test vehicle and (2) the number of turns of the driving wheels. The product of rolling circumference and the number of wheel turns is the computed distance traveled by the test vehicle. The distance observed on the test vehicle odometer is the indicated distance. Tests have indicated that bias ply tires show a definite increase in tire circumference with speed. Consequently at an odometer test speed of 45 mph [70 km] the vehicle travels, on the average, an additional 35 feet per computed mile [6.6 m/km]. Thus, a correction of 35 feet per mile [6.6 m/km] must be added to the computed distance. Bias and radial belted tires have not shown this large variation with speed. No correction is applied to any belted tire.

Results of a study indicate that 3 turns of the odometer driving wheels are sufficient to determine the rolling circumference. Since few tires are perfectly matched in circumference it is necessary to measure the distance traveled by both driving wheels.

Several methods for counting the wheel turns are discussed in Section 3.4.

The test site should be level and may be the interior of a garage or warehouse or an outside parking lot. The minimum length of the test site depends on the length needed for the required turns (see 5.2.3.2.1.) of the odometer driving wheels plus the length of the test vehicle. For most passenger vehicles the three-turn distance will not exceed 26 feet (8 m) (see Figure 28). Twice this distance plus the maximum test vehicle length (approximately 26 feet or 8 m) will require a minimum test site length of 78 feet (24 m) for passenger vehicles. The minimum length for trucks can be computed similarly (and will in general require a longer test site).

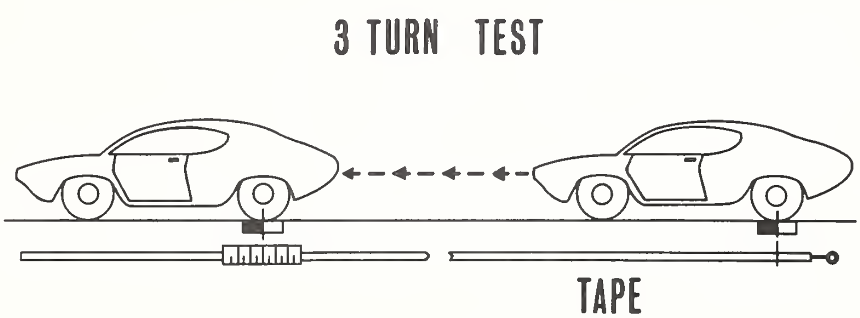


Figure 28. A three-turn test.

5.2.3.2. THE DISTANCE TESTS.- The distance tests in this procedure consist of two parts, namely, the determination of the rolling circumferences of the odometer driving wheels and the determination of the number of turns made by the wheels when exactly two miles [3 km] are indicated by the odometer.

5.2.3.2.1. ROLLING CIRCUMFERENCE DETERMINATION.- The methods for determining the rolling circumference of the tires on the wheels that drive the odometer by means of a "three-turn test" depend on whether one or two persons are conducting the test. Both procedures are given. Where the steps of the procedure are common for both procedures, no letter designation will follow the step number. The steps of the procedure applicable to two persons conducting the test are followed by the letter (a) and those applicable to one person conducting the test are followed by the letter (b). Thus, Step 3(a) denotes a step in the two-man procedure.

Step 1. The tires should be sufficiently warmed up so that there are no "flat spots" in the tires when the test vehicle is driven.

Step 2. Position the test vehicle at one end of the test site.

Step 3(a). Attach a white adhesive label to the odometer-driving tires on the side of the tire where it makes contact with the road. Draw a vertical line to the road surface at the center point of tire contact with the road for each tire. Set marker on road surface at each point.

Step 3(b). Thread a piece of string through one of the wheel slots and around the tread of the tire of one of the wheels driving the odometer (remove any wheel covers if necessary). Tie the two ends of the string together with a slip knot. Repeat procedure with other odometer-driving wheel. Slip a piece of felt pad, 1 in x 2 in (2 cm x 5 cm) under the string with the 2 in (5 cm) length parallel to the string. Slide the felt pad to the outer edge of the tread. Adjust the string so that it is straight across the tread and perpendicular to it. Tighten the string and felt pad securely. Apply white latex paint to the string and felt pad over the tread of each tire. When the vehicle is driven the string and felt pad on each wheel will leave marks on the road surface so that the length of three turns may be measured.

Step 4(a). Drive the vehicle slowly for exactly three turns of the odometer-driving wheels. Set markers. Repeat procedure.

Step 4(b). Drive the vehicle slowly for a minimum of six turns of the odometer-driving wheels.

Step 5. Measure to the closest 1/8 in (3 mm) and record the three turn distance of left and right wheel for each run. In procedure (b) use the first three turns as the first run and the second three turns as the second run.

5.2.3.2.2. WHEEL-TURN DETERMINATION.- When determining the number of wheel turns needed for two odometer miles the odometer driving wheels of the test vehicle may:

(1) be mounted on steel rollers (see Figure 20);
(2) have one wheel raised off the ground (for vehicles that are not equipped with a limited slip differential): or,
(3) both be raised off the ground (for vehicle equipped with a limited slip differential).

The procedures are categorized by these three methods of driving-wheel rotation. Any of the three counters discussed in Section 3.4 may be used with any one of the three methods. The steps of the procedure applicable to a particular counter design will have the letter (a) for the mechanical counter, (b) for the photodiode counter, and (c) for the magnetic counter following the step number (e.g. Step 2(a) applies to mechanical counter procedure). The steps of the procedure that apply to all counters will have no letter designation following the step number.

The first procedure to be outlined is the procedure where the odometer-driving wheels are driven onto steel rollers.

Step 1. Lock the approach roller and drive the vehicle so that the odometer-driving wheels are on the rollers. Unlock the approach roller.

Step 2(a). Remove hub cap or wheel cover from odometer-driving wheels. Attach stud adaptors to wheel studs. Attach wheel adaptor to stud adaptors of each wheel. Attach structural stay to fender with plastic tape. Make certain that each assembly is secure (see Figure 16 for assembly schematic). Make all necessary connections between wheel adaptor, counter, and power supply.

Step 2(b). Attach a piece of self-stick reflective tape to the exterior tire sidewall of each of the odometer-driving wheels (see Figure 29). Make all necessary equipment connections. Direct one photo diode probe toward the sidewall of one of the odometer driving tires. Focus the probe by moving it towards or away from the tire sidewall until the smallest and brightest light spot is obtained. (Optimum distance is about 2 in or 5 cm). Rotate the wheel so that the light impinges on the reflective tape. With the sensitivity adjustment knob set for the lowest sensitivity (no deflection of the needle on the meter) slowly turn the adjustment knob increasing the sensitivity until the deflection of the needle peaks only when the reflective tape crosses the light beam. The needle should return to zero when the probe is focused on the black path of the tire sidewall that does not have the reflective tape or the probe will have to be readjusted. Repeat the probe set up with the other probe and odometer driving tire.

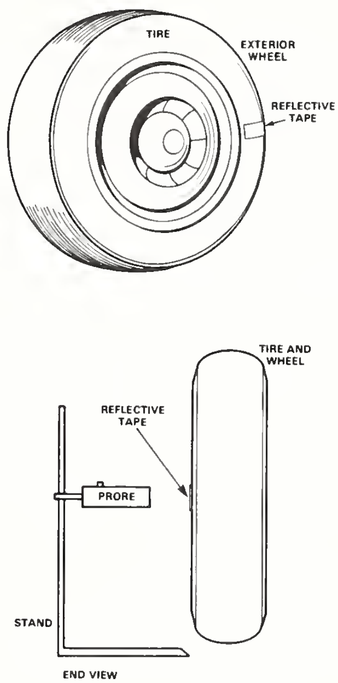


Figure 29. View of wheel and photodiode counter.

Step 2(c). Attach a small bar magnet (approximately 1/4 x 1/8 x 1 in [6 x 3 x 25 mm] to the exterior sidewall of an odometer-driving tire (see Figure 30) with a suitable removable adhesive. Place a magnetic probe near tire sidewall (observe the tire rotation markings on the probe for proper orientation). Rotate the wheel until the magnet is in line with the probe. Adjust the probe so that the magnet will sweep across the opening of the probe lengthwise (see Figure 30). The probe should be about 1/4 in (6 mm) away from the magnet. Repeat the same procedure with the other probe and odometer-driving wheel.

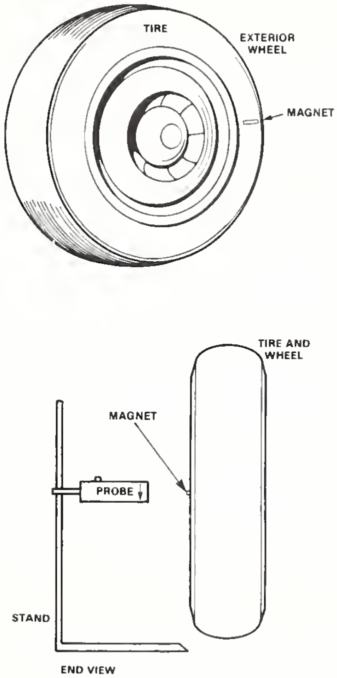


Figure 30. View of wheel and magnetic counter.

Step 3. "Drive" slowly (be sure that both counters are operating) until the horizontal bar of the numeral 2, 4, 5, or 7 of the 1/10 mile [0.1 km] indicator is lined up with the top or bottom of the odometer window and stop. The position of the selected numeral of the 1/10 mile [0.1 km] indicator (see Figure 26) can be most easily reproduced if aligned closely to the upper or lower edge of the odometer window.

Step 4. Record odometer reading and reset the counters to zero.

Step 5. Accelerate to 45 mph [70 km/h]. The rate of speed is not critical in conducting this test since only wheel turns are being counted. However, the speed should not exceed 60 mph [95 km/h] for reasons of safety and because the system capability for accurate counting may be exceeded. As the end of the two-mile [3 km] run is approached on the odometer decelerate and stop when the 1/10 mile [0.1 km] indicator is at exactly the same position as at the start of the test.

Step 6. Record odometer and counter readings.

Step 7. Reset the counters to zero and repeat the run.

Step 8. Lock the approach roller and drive test vehicle off the rollers.

The second wheel turn counting procedure uses one odometer driving wheel raised off the ground with a jack and is intended solely for vehicles not equipped with a limited slip differential.

Step 1. Raise one odometer driving wheel safely off the ground with a scissors or hydraulic jack. With the other wheels chocked, the brakes released, and the transmission in neutral, try turning the raised wheel several revolutions. If this can be done, continue with Steps 2 through 7 of the preceding steel roller procedure. Since tests will be made with only one wheel, references to set up, counters, and data collection for the other odometer-driving wheel can be ignored. The speed of operation should be held to about 23 mph (37 km/h) and not exceed 30 mph (48 km/h). If the raised wheel cannot be turned this indicates that the test vehicle has a limited slip differential. Go to the next procedure dealing with vehicles equipped with a limited slip differential.

Step 8. Return raised wheel to normal ground position. Remove jack and drive test vehicle away.

The third-wheel turn counting procedure consists of raising both odometer driving wheels off the ground with jacks and is intended solely for vehicles equipped with a limited slip differential.

Step 1. Raise both odometer driving wheels off the ground with scissors or hydraulic jacks. Continue with Steps 2 through 7 of the preceding steel roller procedure.

Step 8. Return raised wheels to the normal ground position. Remove jacks and drive test vehicle away.

6. TEST REPORT FORMS

A report form should contain all the pertinent information required to conduct, record, and refer to a proper examination and test of a taximeter or odometer. This includes complete identification of the taxicab and taximeter or vehicle under test, a record of distance traveled during the tests; complete documentation of the test date, number, and data; results of examination and test; any remarks or instructions, and validation by the inspector and the owner or operator of the vehicle.

6.1. TAXIMETER.- A suggested Taximeter Test Report Form is shown in Figure 31. The form provides space in the upper portion for owner and equipment indentification. In the body of the form is space for recording the various test runs and for the calculations involved. At the bottom is space for indicating the official action taken as a result of the test, any remarks or instructions, the signature of the inspector, and the "acknowledgment" signature of equipment owner or operator. The upper portion of the report form should be filled in completely before the test is initiated.

6.2. ODOMETER.- A suggested Odometer Test Report Form for the measured course or fifth wheel test procedures is shown in Figure 32 and for the simulated road test procedures in Figure 33. The forms provide space in sections A and B for the necessary owner, vehicle, and tire identification. Section C of the forms provides space for recording the test data for two or three separate test runs and for the calculations involved. Sections D and E provide space for indicating the official action taken as a result of the test, any remarks or instructions, the signature of the inspector, and the "acknowledgment" signature of the vehicle owner or operator. Sections A and B of the Report Form should be filled in completely prior to operation of the vehicle for test purposes except for the tire pressures. A separate form should be used for each vehicle tested. Additional forms should be used if more runs are required than are provided for by the form.

7. REPORTING A TEST

In reporting a test the inspector documents all pertinent information that is concerned with the device he is testing. Since the device is a part of a system the report forms call for information related to the complete system and not just the device. A properly executed report of test will leave no questions or cause any misinterpretation of the report.

7.1. TAXIMETER.- The inspector should fill in the date, test number, and Section A (Vehicle and Taximeter Identification) including the "start" section of the totalizer record if the taximeter is equipped with a totalizer. If the taximeter is not equipped with a totalizer enter the odometer indication.

Enter the test data in the appropriate spaces of Section B during and immediately following the test runs. At the conclusion of the tests, complete "finish" portion of the totalizer record or enter the odometer indication if the taximeter is not equipped with one.

In Figures 34(a) and 34(b) a sample taximeter report form has been filled out with the distance tests conducted using a measured course. Section B of the report form is concerned with the test data. The data on the distance and interference test is presented as indicated

DEPARTMENT HEADING

Date________ TAXIMETER TEST REPORT FORM Test No.__________

A. Vehicle and Taximeter Identification:

Owner______________________________ Address______________________________

Name of Taxicab Co.____________________________ Fleet No.______________

Make of Cab________________________ Year__________ License No.______________

Make of Taximeter__________________ Model__________ Serial No.______________

Tires: Ply_____ Snow_____ Reg._____ Size_____ Condition_____ Pressure_______

Type____________________ (Odometer Driving Tires)

Totalizer Record:

	Total Distance	Paid Distance	Units	Trips
Start				
Finish				

B. Test Data:

1. Distance Drop Test: Initial Distance_____ Subsequent Distances_____ each
2. Temperature_______
3. Road Conditions____
4. Distance and Interference Tests:

Interval	1st Run			2nd Run			Interference Test		
	Meas.Dist.	In	Out	Meas.Dist	In	Out	Meas.Dist.	In	Out
1st Drop									
2nd Drop									
3rd Drop									
4th Drop									
5th Drop									

NOTE: Enter actual measured distance or corrected readings from electric counter for each run in proper drop sequence, or indicate whether error is plus (+), minus (-), or zero (no error) and if in tolerance by checking IN, if out of tolerance by checking OUT. If the actual measured distance of the vehicle exceeds the distance measured by the taximeter the error is plus.

5. Timer Interval Test: Initial Drop_________ Subsequent Drops_________

Interval	Elapsed Time		Individual Time		Error			
	min	s	min	s	min	s	IN	OUT
1st Drop								
2nd Drop								
3rd Drop								
4th Drop								
5th Drop								
Avg. (exclude 1st drop)								

C. Results of Examination and Test:

1. Action Taken: Approved_________ Rejected_________ Condemned_________
2. Remarks:____

____

____________________ ____________________

Inspector Owner or Operator

Figure 31. A sample taximeter test report form

DEPARTMENT HEADING
ODOMETER TEST REPORT FORM

Date____________________ Test No.________________

A. Vehicle Identification:

Owner__________________________ Address____

Make of Car____________________ Year and Model______________ Body Style______________

License No.____________________ Serial No.__________________ Co. Ident. No.___________

B. Description of Odometer Driving Tires

Condition________________ Style__________________ Ply________________ Size______________

Tire Pressure: After Stabilization________________ After 1st Run_________________________

After 2nd Run______________________ After 3rd Run_________________________

C. Test Data:

Temperature____________________ Road Conditions____

		1st Run	2nd Run	3rd Run
	Orientation of 1/10____indicator	☐	☐	☐
1.	Odometer end of test	______	______	______
2.	Odometer start of test	______	______	______
3.	Odometer distance (Item 1-Item 2)	______	______	______
	Items 4 through 7 for fifth wheel only			
4.	Test instrument reading	______	______	______
5.	Calibration correction (x 2 for mi) or (x 3 for km)	______	______	______
6.	True distance (Item 4 + Item 5)	______	______	______
7.	Error (see note)	______	______	______
8.	Percent error $\frac{(\text{Item 7} \times 100)}{(\text{Item 3})}$	______	______	______

NOTE: If true distance reading (Item 6) is smaller than the odometer reading (Item 3), the vehicle is overregistering and a minus sign should be used for the error. If the true distance reading is larger than the odometer reading, the vehicle is underregistering and a plus sign should be used for the error value.

D. Action Taken: Approved___________ Rejected___________ Condemned___________

E. Remarks:____

____

_________________________ _________________________

Inspector Owner/Operator

Figure 32. A suggested odometer test report form for use with the measured-course or fifth-wheel test procedures

DEPARTMENT HEADING
ODOMETER TEST REPORT FORM
(Simulated Road Test)

Date________________ Test No.________

A. Vehicle Identification:
Owner_______________________________Address_____________________________________
Make of Car_____________________Year and Model______________Body Style_________
License No.________________Serial No. ______________Co. Ident. No. ______________
Limited Slip Differential__________________________

B. Description of Odometer Driving Tires:
Condition_____________Style_______________Ply_______________Size______________
Tire Pressure________________

C. Test Data: Temperature	1st Run	2nd Run	Average
Three turn distance			
1. Left wheel			
2. Right wheel			
3. Average			
4. Average/turn (Item 3÷3)			
Odometer test			
Orientation: 1/10 indication			
5. Odometer (end of test)			
6. Odometer (start of test)			
7. Odometer distance			
Wheel turns			
8. Left wheel			
9. Right wheel			
10. Average			
11. Uncorrected distance (Item 4 x Item 10)			
12. Correction (enter 70 feet [or 20 meters] if tires are bias ply only)			
13. Corrected distance (Item 11 + Item 12)			
14. Subtract * from Item 13 (retain sign) This is the error in feet or meters (see Item 13)			
15. Divide Item 14 by * x 100 (retain sign) This is the error in %			

* (Item 7 x 5280, for miles, or x 1000, for km)

NOTE: If simulated distance reading (Item 13) is smaller that the odometer distance (Item 7), the vehicle is overregistering and the error is minus. If the simulated distance is larger than the odometer distance, the vehicle is underregistering and the error is plus.

D. Action taken: Approved__________Rejected___________Condemned__________

E. Remarks:____

______________________ Inspector

______________________ Owner/Operator

Figure 33. A suggested odometer test report form for use with the simulated road test

in Figures 34(a) and 34(b) or Figures 35(a) and 35(b). In Figures 34(a) and 34(b) the error in the distance measured by the taximeter is plus if underregistering and minus if overregistering. The inspector will determine the presence of any interference in a test conducted after the distance tests. If interference is suspected the error must be recorded for each drop in the distance and interference tests. In Figures 35(a) and 35(b), the actual measured distance is determined using a fifth-wheel. The drop distances in the interference test should be within one percent of the drop distances in the distance tests.

The column entries of the time interval test data section (Figures 34(a) and 34(b)), are generally self-explanatory. The individual time interval for the first drop is the same as the elapsed time for the first drop. The individual time interval for the succeeding drops is the elapsed time for the drop minus the elapsed time for the preceding drops. Thus, the individual time interval for the second drop is the elapsed time for the second drop minus the elapsed time for the first drop.

Example:

elapsed time at second drop = 3 min 6 sec.
elapsed time at first drop = 1 min 34 sec.
3 min 6 sec - 1 min 34 sec = 1 min 32 sec.

The individual time interval error is calculated by subtracting the calculated time interval per money drop from the individual time interval and retaining the arithmetic sign. If the individual time interval is larger than the calculated time interval per money drop the arithmetic sign is plus (+). If the reverse is true the arithmetic sign is minus (-).

Example:

1 min 34 sec = individual time interval
1 min 30 sec = calculated time interval per money drop
1 min 34 sec - 1 min 30 sec = +4 sec

The average time interval is computed as follows:

$$\frac{\text{Elapsed time (last drop) - Elapsed time (first drop)}}{\text{Number of last drop - 1}}$$

Example: i.e.

$$\frac{\text{7 min 37 sec - 1 min 34 sec}}{5-1} = \frac{\text{6 min 3 sec}}{4} = \text{1 min 30.8 sec}$$

7.2. ODOMETER.- In the odometer test report forms, all available descriptive information in Section A and B of the report form is entered prior to the start of the test. The tire pressure of the tires on the wheels that drive the odometer are reported in Section B of the report forms.

In the test data section of the form, each line for each run is identified by an item number. The steps and entries in the data calculations refer to the identifying item number for the appropriate runs.

7.2.1. MEASURED COURSE PROCEDURES.- The test data sections of an odometer test report form (measured course screening test) are given in Figures 36a & b. They are similar to the test data sections (measured course possible violation test) given in Figures 37a & b except for the orientation of 1/10 mile [0.1 km] indication. It should be noted that items 4 through 7 are not applicable to measured course procedures.

Step 1. The odometer distance (Item 3) is the odometer reading at the end of the test (Item 1) minus the odometer reading at the start of the test (Item 2).

Step 2. The percent error is the error as determined in the finish zone of the measured course (to the closest 1/4%). See Figure 24.

7.2.2. FIFTH WHEEL TEST PROCEDURE.- The test data sections of an odometer test report (fifth wheel test procedure) are given in Figure 38a & b.

Date 5/29/76 TAXIMETER TEST REPORT FORM Test No. 3

A. Vehicle and Taximeter Identification:
Owner Joe Harker Address 1327 Checker Lane
Name of Taxicab Co. Orange Cab Fleet No. 5
Make of Cab Metro Year 1976 License No. D178752
Make of Taximeter Tru-Measure Model M08 Serial No. 5280
Tires: Ply 4 Snow ____ Reg. ____ Size G78-14 Condition new Pressure 28 psi
Type bias ply polyester (Odometer Driving Tires)
Totalizer Record:

	Total Distance	Paid Distance	Units	Trips
Start	2975.6 mi	2100.2 mi	7103	631
Finish	2979.6	2103.7	7123	636

B. Test Data:
1. Distance Drop Test: Initial Distance 1/5 mi Subsequent Distances 1/5 mi each
2. Temperature 80°F
3. Road Conditions Dry
4. Distance and Interference Tests:

Interval	1st Run			2nd Run			Interference Test		
	Meas.Dist.	In	Out	Meas.Dist	In	Out	Meas.Dist.	In	Out
1st Drop	+	✓		+	✓		+	✓	
2nd Drop	+	✓		+	✓		+	✓	
3rd Drop	+	✓		+	✓		+	✓	
4th Drop	+	✓		+	✓		+	✓	
5th Drop	+	✓		+	✓		+	✓	

NOTE: Enter actual measured distance or corrected readings from electric counter for each run in proper drop sequence, or indicate whether error is plus (+), minus (-), or zero (no error) and if in tolerance by checking IN, if out of tolerance by checking OUT. If the actual measured distance of the vehicle exceeds the distance measured by the taximeter the error is plus.

5. Timer Interval Test: Initial Drop 1 min 30 s Subsequent Drops 1 min 30 s

Interval	Elapsed Time		Individual Time		Error			
	min	s	min	s	min	s	IN	OUT
1st Drop	1	34	1	34		+4	✓	
2nd Drop	3	06	1	32		+2	✓	
3rd Drop	4	38	1	32		+2	✓	
4th Drop	6	08	1	30		0	✓	
5th Drop	7	37	1	29		-1	✓	
Avg.	(exclude 1st drop)		1	30.8		+0.8	✓	

C. Results of Examination and Test:
1. Action Taken: Approved ✓ Rejected ____ Condemned ____
2. Remarks: Posted operating tire pressure is 28 psi.

______________________ ______________________
Inspector Owner or Operator

Figure 34a. A completed taximeter test report form (inch-pound units).

DEPARTMENT HEADING

Date 6/28/77 TAXIMETER TEST REPORT FORM Test No. 4

A. Vehicle and Taximeter Identification:
Owner Joe Hacker Address 1327 Checker Lane
Name of Taxicab Co. Orange Cab Fleet No. 5
Make of Cab Metro Year 1976 License No. D178 752
Make of Taximeter Tru-Measure Model MO 8 Serial No. 5280
Tires: Ply 4 Snow ___ Reg. ✓ Size 195R-14 Condition new Pressure 190 kPa
Type steel radial (Odometer Driving Tires)
Totalizer Record:

	Total Distance	Paid Distance	Units	Trips
Start	1560.6 km	1041.2 km	6214	528
Finish	1567.8	1047.5	6236	535

B. Test Data:
1. Distance Drop Test: Initial Distance 0.5 km Subsequent Distances 0.5 km each
2. Temperature 27 °C
3. Road Conditions Dry
4. Distance and Interference Tests:

Interval	1st Run			2nd Run			Interference Test		
	Meas.Dist.	In	Out	Meas.Dist	In	Out	Meas.Dist.	In	Out
1st Drop	+	✓		+	✓		+	✓	
2nd Drop	+	✓		+	✓		+	✓	
3rd Drop	+	✓		+	✓		+	✓	
4th Drop	+	✓		+	✓		+	✓	
5th Drop									

NOTE: Enter actual measured distance or corrected readings from electric counter for each run in proper drop sequence, or indicate whether error is plus (+), minus (-), or zero (no error) and if in tolerance by checking IN, if out of tolerance by checking OUT. If the actual measured distance of the vehicle exceeds the distance measured by the taximeter the error is plus.

5. Timer Interval Test: Initial Drop 1 min 30 s Subsequent Drops 1 min 30 s

Interval	Elapsed Time		Individual Time		Error			
	min	s	min	s	min	s	IN	OUT
1st Drop	1	34	1	34		+4	✓	
2nd Drop	3	06	1	32		+2	✓	
3rd Drop	4	38	1	32		+2	✓	
4th Drop	6	08	1	30		0	✓	
5th Drop	7	37	1	29		−1	✓	
Avg.	(exclude 1st drop)		1	30.8		+0.8		

C. Results of Examination and Test:
1. Action Taken: Approved ✓ Rejected ___ Condemned ___
2. Remarks: Posted operating tire pressure is 190 kPa

Inspector Owner or Operator

Figure 34b. A completed taximeter test report form (metric units)

4. Distance and Interference Tests:

Interval	1st Run			2nd Run			Interference Test		
	Meas.Dist.	In	Out	Meas.Dist	In	Out	Meas.Dist.	In	Out
1st Drop	0.204 mi	✓		0.205 mi	✓		0.204 mi	✓	
2nd Drop	0.408	✓		0.409	✓		0.409	✓	
3rd Drop	0.612	✓		0.613	✓		0.612	✓	
4th Drop	0.817	✓		0.817	✓		0.817	✓	
5th Drop	1.021	✓		1.022	✓		1.021	✓	

NOTE: Enter actual measured distance or corrected readings from electric counter for each run in proper drop sequence, or indicate whether error is plus (+), minus (-), or zero (no error) and if in tolerance by checking IN, if out of tolerance by checking OUT. If the actual measured distance of the vehicle exceeds the distance measured by the taximeter the error is plus.

Figure 35a. Distance and interference test data using actual measured distance (inch-pound units).

4. Distance and Interference Tests:

Interval	1st Run			2nd Run			Interference Test		
	Meas.Dist.	In	Out	Meas.Dist	In	Out	Meas.Dist.	In	Out
1st Drop	0.507 km	✓		0.508 km	✓		0.507 km	✓	
2nd Drop	1.015	✓		1.015	✓		1.015	✓	
3rd Drop	1.522	✓		1.523	✓		1.522	✓	
4th Drop	2.031	✓		2.030	✓		2.031	✓	
5th Drop									

NOTE: Enter actual measured distance or corrected readings from electric counter for each run in proper drop sequence, or indicate whether error is plus (+), minus (-), or zero (no error) and if in tolerance by checking IN, if out of tolerance by checking OUT. If the actual measured distance of the vehicle exceeds the distance measured by the taximeter the error is plus.

Figure 35b. Distance and interference test data using actual measured distance (metric units).

DEPARTMENT HEADING
ODOMETER TEST REPORT FORM

Date 7/15/76 Test No. 12

A. Vehicle Identification:
Owner U-Rent-M Address 1510 South Ave, Wheaton, Md.
Make of Car Metro Year and Model 1976 arrow Body Style 4-dr sedan
License No. ACF 720 Serial No. LL 17891 Co. Ident. No. 3

B. Description of Odometer Driving Tires
Condition Good Style Reg Ply 2 Size D78-14
Tire Pressure: After Stabilization 28 psi After 1st Run 28 psi
After 2nd Run 28 psi After 3rd Run

C. Test Data:
Temperature 85°F Road Conditions Dry

		1st Run	2nd Run	3rd Run
	Orientation of 1/10 mi indicator	3	7	
1.	Odometer end of test	3582 mi	3586 mi	
2.	Odometer start of test	3580	3584	
3.	Odometer distance (Item 1-Item 2)	2	2	
	Items 4 through 7 for fifth wheel only			
4.	Test instrument reading			
5.	Calibration correction x 2			
6.	True distance (Item 4 + Item 5)			
7.	Error (see note)			
8.	Percent error (Item 7 x 100) / (Item 3)	+0.5	+0.5	

NOTE: If true distance reading (Item 6) is smaller than the odometer reading (Item 3), the vehicle is overregistering and a minus sign should be used for the error. If the true distance reading is larger than the odometer reading, the vehicle is underregistering and a plus sign should be used for the error value.

D. Action Taken: Approved ✓ Rejected ____ Condemned ____

E. Remarks: Posted operating tire pressure is 28 psi

Inspector Owner/Operator

Figure 36a. A completed odometer test report form (measured-course screening test in inch-pound units)

DEPARTMENT HEADING
ODOMETER TEST REPORT FORM

Date 11/19/79 Test No. 8

A. Vehicle Identification:
Owner U-Rent-M Address 1510 South ave, Wheaton, Md
Make of Car Metro Year and Model 1979 Arrow Body Style 4-dr sedan
License No. WAM 340 Serial No. WM378582 Co. Ident. No. 4

B. Description of Odometer Driving Tires
Condition Good Style Snow Ply ____ Size 195R-14
Tire Pressure: After Stabilization 190 kPa After 1st Run 190 kPa
After 2nd Run 190 kPa After 3rd Run ____

C. Test Data:
Temperature 12°C Road Conditions Dry

		1st Run	2nd Run	3rd Run
	Orientation of 1/10 km indicator			
1.	Odometer end of test	28343 km	28349 km	
2.	Odometer start of test	28340	28346	
3.	Odometer distance (Item 1-Item 2)	3 km	3 km	
	Items 4 through 7 for fifth wheel only			
4.	Test instrument reading			
5.	Calibration correction x 3			
6.	True distance (Item 4 + Item 5)			
7.	Error (see note)			
8.	Percent error (Item 7 x 100) / (Item 3)	+0.8	+0.7	

NOTE: If true distance reading (Item 6) is smaller than the odometer reading (Item 3), the vehicle is overregistering and a minus sign should be used for the error. If the true distance reading is larger than the odometer reading, the vehicle is underregistering and a plus sign should be used for the error value.

D. Action Taken: Approved ✓ Rejected ____ Condemned ____

E. Remarks: Posted operating tire pressure is 190 kPa

Inspector Owner/Operator

Figure 36b. A completed odometer test report form (measured-course screening test in metric units)

C. Test Data:

Temperature 72°F Road Conditions Dry

	1st Run	2nd Run	3rd Run
Orientation of 1/10 mi indicator	7	2	
1. Odometer end of test	6360 mi	6364 mi	
2. Odometer start of test	6358	6362	
3. Odometer distance (Item 1-Item 2)	2 mi	2 mi	
Items 4 through 7 for Fifth Wheel Only			
4. Test instrument reading			
5. Calibration correction x 2			
6. True distance (Item 4 + Item 5)			
7. Error (see note)			
8. Percent error $\frac{\text{Item 7} \times 100}{\text{Item 3}}$	-4.25	-4.25	

Figure 37a. Test data of a completed odometer test report form (measured-course possible violation test in inch-pound units)

C. Test Data:

Temperature 13°C Road Conditions Dry

	1st Run	2nd Run	3rd Run
Orientation of 1/10 km indicator	5	4	
1. Odometer end of test	42848 km	42853 km	
2. Odometer start of test	42845	42850	
3. Odometer distance (Item 1-Item 2)	3 km	3 km	
Items 4 through 7 for Fifth Wheel Only			
4. Test instrument reading			
5. Calibration correction x 3			
6. True distance (Item 4 + Item 5)			
7. Error (see note)			
8. Percent error $\frac{\text{Item 7} \times 100}{\text{Item 3}}$	-4.8	-4.9	

Figure 37b. Test data of a completed odometer test report form (measured-course possible violation test in metric units)

C. Test Data:

Temperature 78°F Road Conditions Dry

	1st Run	2nd Run	3rd Run
Orientation of 1/10 mi indicator	5	4	
1. Odometer end of test	23693 mi	23696 mi	
2. Odometer start of test	23691	23694	
3. Odometer distance (Item 1-Item 2)	2 mi	2 mi	
Items 4 through 7 for Fifth Wheel Only			
4. Test instrument reading	1.994 mi	1.995 mi	
5. Calibration correction x 2	+0.002	+0.002	
6. True distance (Item 4 + Item 5)	1.996	1.997	
7. Error (see note)	-0.004	-0.003	
8. Percent error (Item 7 x 100) / (Item 3)	-0.20	-0.15	

NOTE: If true distance reading (Item 6) is smaller than the odometer reading (Item 3), the vehicle is overregistering and a minus sign should be used for the error. If the true distance reading is larger than the odometer reading, the vehicle is underregistering and a plus sign should be used for the error value.

Figure 38a. Test data of a completed odometer test report form (fifth-wheel test in inch-pound units)

Temperature 11°C Road Conditions Dry

	1st Run	2nd Run	3rd Run
Orientation of 1/10 km indicator	6	2	
1. Odometer end of test	38652 km	38658 km	
2. Odometer start of test	38649	38655	
3. Odometer distance (Item 1-Item 2)	3 km	3 km	
Items 4 through 7 for Fifth Wheel Only			
4. Test instrument reading	3.011 km	3.013 km	
5. Calibration correction x 3	+0.003	+0.003	
6. True distance (Item 4 + Item 5)	3.014	3.016	
7. Error (see note)	+0.014	+0.016	
8. Percent error (Item 7 x 100) / (Item 3)	+0.47	+0.53	

NOTE: If true distance reading (Item 6) is smaller than the odometer reading (Item 3), the vehicle is overregistering and a minus sign should be used for the error. If the true distance reading is larger than the odometer reading, the vehicle is underregistering and a plus sign should be used for the error value.

Figure 38b. Test data of a completed odometer test report form (fifth-wheel test in metric units)

Step 1. The odometer distance (Item 3) is the odometer reading at the end of the test (Item 1) minus the odometer reading at the start of the test (Item 2).

Step 2. The test instrument reading (Item 4) is the reading of the fifth wheel at the end of a run.

Step 3. The calibration correction (Item 5) is the fifth wheel calibration correction which is generally expressed in plus (+) or minus (-) thousandths of a mile per mile in inch-pound units and is multiplied by 2 since the test runs are two miles in length. When using metric units, the calibration correction would be expressed in thousandths of a kilometer (meters) and multiplied by three, the number of kilometers required for a test run.

Step 4. The true distance (Item 6) is the sum of Item 4 and Item 5.

Step 5. The error (Item 7) is the true distance (Item 6 minus the odometer distance (Item 3). The proper plus (+) or minus (-) sign should be carried; thus, if the true distance reading (Item 6) is smaller than the odometer reading (Item 3) the vehicle is overregistering and a minus sign should be used for the error. If the true distance reading is larger than the odometer reading the vehicle is underregistering and a plus sign should be used for the error.

Step 6. The percent (%) error (Item 8) is determined by dividing the error (Item 7) by the odometer distance (Item 3) and multiplying by 100. Be sure to carry the appropriate plus (+) or minus (-) sign.

7.2.3. SIMULATED ROAD TEST PROCEDURES.- A completed odometer report form (simulated road test) is given in Figure 39 in inch-pount units and in Figure 40 in metric units.

Step 1. The average three-turn distance for the two test runs (Item 3) is the average of the three-turn distances of left and right odometer-driving wheels (Items 1 and 2) for both runs (1st run and 2nd run) of the test vehicle.

Step 2. The average/turn or the rolling circumference of the odometer driving wheels (Item 4) is Item 3 divided by 3.

Step 3. The odometer distance (Item 7) is the odometer reading at the end of the test (Item 5) minus the odometer reading at the start of the test (Item 6).

Step 4. The average wheel turns per odometer distance (Item 10) is the average of the wheel turns of the left and right wheels (Item 8 and 9) for the first two runs. If only one wheel is used the average is the sum of two runs divided by four.

Step 5. The uncorrected distance (Item 11) is the average rolling circumference (Item 4) multiplied by the average wheel turns per odometer distance (Item 10).

Step 6. The correction (Item 12) is always plus and is only applied if the tires are bias ply. The correction is 70 feet or 0.020 km. No correction is applied for bias or radial belted tires.

Step 7. The corrected distance (Item 13) is the uncorrected distance (Item 11) plus the correction (Item 12).

Step 8. Subtract the odometer distance (Item 7 times 5280 for miles or 1000 for km) from the corrected distance and retain the sign. This is the error in the units of length being used (feet or meters).

Step 9. Divide Item 14 by the odometer distance (Item 7 times 5280 for miles or 1000 for km) whichever is appropriate to remain in the same units) and multiply by 100. This is the error in percent.

DEPARTMENT HEADING
ODOMETER TEST REPORT FORM
(Simulated Road Test)

Date 8/18/76 Test No. 15

A. Vehicle Identification:
Owner U-Rent-M Address 1510 South ave, Wheaton
Make of Car Metro Year and Model 1976 arrow Body Style 2-dr hardtop
License No. ACF 721 Serial No. LL18643 Co. Ident. No. 4
Limited Slip Differential No

B. Description of Odometer Driving Tires:
Condition Good Style Reg Ply 2/Bias Size E78-14
Tire Pressure 28 psi

C. Test Data: Temperature 72 °F	1st Run	2nd Run	Average
Three turn distance ft-in			
1. Left wheel	17-1	17-3/4	
2. Right wheel	17-1 3/4	17-1	
3. Average			17-1 1/8
4. Average/turn (Item 3÷3) ft			5.698
Odometer test			
Orientation: 1/10 mi indication	5	4	
5. Odometer (end of test) mi	5912.5	5915.4	
6. Odometer (start of test) mi	5910.5	5913.4	
7. Odometer distance mi	2.0	2.0	2.0
Wheel turns			
8. Left wheel	1812	1813	
9. Right wheel	1816	1816	
10. Average			1814.25
11. Uncorrected distance (Item 4 x Item 10) ft			10337.6
12. Correction (enter 70 feet if tires are bias ply only)			+70
13. Corrected distance (Item 11 + Item 12) ft			10407.6
14. Subtract * from Item 13 (retain sign) This is the error in feet or meters (see Item 13) ft			-152.4
15. Divide Item 14 by * x 100 (retain sign) This is the error in %			-1.44

* (Item 7 x 5280, for miles, or x 1000, for km)

NOTE: If simulated distance reading (Item 13) is smaller that the odometer distance (Item 7), the vehicle is overregistering and the error is minus. If the simulated distance is larger than the odometer distance, the vehicle is underregistering and the error is plus.

D. Action taken: Approved ✓ Rejected ____ Condemned ____

E. Remarks: ____

Inspector Owner/Operator

Figure 39. A completed odometer test report form in inch-pound units (simulated road test)

DEPARTMENT HEADING
ODOMETER TEST REPORT FORM
(Simulated Road Test)

Date 8/18/76 Test No. 16

A. Vehicle Identification:

Owner U-Rent-M Address 1510 South Ave, W. heaton

Make of Car Metro Year and Model 1976 Arrow Body Style 2-dr HT

License No. ACF-721 Serial No. LL18643 Co. Ident. No. 4

Limited Slip Differential No

B. Description of Odometer Driving Tires:

Condition Good Style Reg Ply Steel radial Size 195R-14

Tire Pressure 193 kPa

C. Test Data: Temperature 22 °C	1st Run	2nd Run	Average
Three turn distance m			
1. Left wheel	5.207	5.201	
2. Right wheel	5.226	5.207	
3. Average			5.210
4. Average/turn (Item 3÷3) m			1.737
Odometer test			
Orientation: 1/10 km indication	5	2	
5. Odometer (end of test) km	9515.5	9523.2	
6. Odometer (start of test)	9512.5	9520.2	
7. Odometer distance km	3.0	3.0	3.0
Wheel turns			
8. Left wheel	1693	1693	
9. Right wheel	1689	1690	
10. Average			1691.25
11. Uncorrected distance (Item 4 x Item 10) m			2937.7
12. Correction (enter 20 meters if tires are bias ply only)			0
13. Corrected distance (Item 11 + Item 12) m			2937.7
14. Subtract * from Item 13 (retain sign) This is the error in feet or meters (see Item 13) m			-62.3
15. Divide Item 14 by * x 100 (retain sign) This is the error in %			-2.08

* (Item 7 x 5280, for miles, or x 1000, for km)

NOTE: If simulated distance reading (Item 13) is smaller that the odometer distance (Item 7), the vehicle is overregistering and the error is minus. If the simulated distance is larger than the odometer distance, the vehicle is underregistering and the error is plus.

D. Action taken: Approved ✓ Rejected ___ Condemned ___

E. Remarks:

Inspector

Owner/Operator

Figure 40. A completed odometer test report form in metric units (simulated road test)

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This is a manual for State and local weights and measures officials, describing distance measuring devices such as odometers and taximeters to be tested, testing equipment and its calibration, inspection and testing procedures, and a reporting system. Provision is made for accommodating a changeover to metric units of device examination in the definitions, tables, procedures, and in reporting a test.

12. KEY WORDS *(Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons)*

Calibration; distance; fifth wheel; inspection; measured course; odometer; taximeter; test procedure; tire pressure; tolerances.

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