California Environmental Protection Agency

Air Resources Board

Vapor Recovery Test Procedure

~~PROPOSED~~MODIFIED: TP - 201.2C

Spillage from Phase II Systems

Adopted: April 12, 1996
Amended___________

Proposed 15-day changes are shown with underline for additions and ~~strikeout for deletions.~~

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TP-201.2C

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A set of definitions common to all Certification and Test Procedures is in:

D-200 Definitions for Vapor Recovery Procedures

For the purpose of this procedure, the term "CARB" refers to the California Air Resources Board, and the term "Executive Officer" refers to the CARB Executive Officer, or his or her authorized representative or designate.

1. PURPOSE AND APPLICABILITY

1.1 The purpose of this procedure is to quantify the frequencies and quantities of liquid gasoline spilled during vehicle refueling events. It is applicable for determining compliance with the allowable mass emission factor for spillage as defined in the Certification Procedure (CP-201).

2. PRINCIPLE AND SUMMARY OF TEST PROCEDURE

2.1 The vapor recovery nozzles and associated hanging hardware are inspected and verified to be in good working order, ~~as specified in subsections (d) and (e) of Section 41960.2 of the California Health & Safety Code~~ pursuant to title 17, CCR, section 94006. A pre-test calibration of gasoline spills versus spill area is performed. This calibration will determine the spill areas created by 1 ml, 2 ml, 3 ml, 4 ml, 5 ml, 10 ml, 25 ml, and 50 ml of gasoline at the location of the test. When the calibration is completed, vehicle refuelings are observed, and measurements are made to quantify all observed spills.

2.2 A calibration of pours shall be conducted at each test site. The gasoline shall be poured on an area of the pavement which is representative of the pavement where the majority of vehicle spills occur so that the results of the calibration of pour volume to area can be representative for each site. A Calibration Graph or Calibration Equation shall be developed from the calibration pours.

3. BIASES AND INTERFERENCES

3.1 Different pavements can cause different spill areas for a specific quantity of spilled gasoline. Dirt or inadequately cleaned absorbent could also affect the spill areas.

3.2 The tester could subjectively select certain vehicles over others. To eliminate this potential bias, a consistent method of vehicle selection is described in the test procedure. Except as noted in Section 6.1.1, the tester must choose the first vehicle that appears in his/her field of view, for which the fueling episode has not yet begun.

3.3 The tester could bias the results toward less lower mass emissions from pre-fueling spillage if their field of view does not include the access zone for the fillpipe. To eliminate this possible bias, the tester shall be positioned such that any gasoline spilled in the fillpipe access zone is observed.

3.4 The results could be biased toward lower mass emissions from spillage if the surface at the refueling location is extremely hot due to direct sunlight. To minimize this possible bias, spill size measurements shall be taken as specified in Section 6.3.1(c). If evaporation has already shrunk the original spill area prior to a measurement, every attempt to shall be made to use the stain outline to obtain an accurate area of the actual spill.

3.5 The results will be biased if the specific weight of gasoline is different than 6.28 pounds per gallon. Use ~~the specific weight~~ 6.28 pounds per gallon as the specific weight of gasoline unless otherwise specified by the Executive Officer~~, that typifies the gasoline being dispensed at the facility to eliminate the bias~~.

3.6 The results of the calibration of spill volume versus spill size may be biased if the rate of the calibration pours vary significantly. Ensure that the rates of each of the triplicate pours are approximately uniform.

4. SENSITIVITY, RANGE, AND PRECISION

4.1 The procedure is capable of determining spills as small as one drop per refueling event. For the purpose of this procedure, any loss of liquid gasoline greater than, or equal to, one drop shall be recorded as spillage.~~ The calculation below demonstrates the air quality impact attributable to a single drop of gasoline spilled during each refueling event in California, assuming 14.2 billion gallons per year and an average refueling event of 10 gallons.~~

$$\left(\frac{1\,drop}{10\,gallons}\right)\left(\frac{14.2\times10^{9}\,gallons}{year}\right)\left(\frac{1\,ml}{20\,drops}\right)\left(\frac{1\,gallon}{3{,}785\,ml}\right)\left(\frac{6.28\,lb}{gallon}\right)\left(\frac{1\,ton}{2{,}000\,lb}\right)=\frac{58.9\,tons\,HC}{year}$$

D E L E T E   A B O V E   E Q U A T I O N

4.2 Maximum sensitivity and precision is obtained by observing dripping episodes and recording data using, as an approximation, 20 drops of gasoline =1 ml. The sensitivity of the procedure is 1 drip/refueling event and the precision is ± 1 drip/refueling event.

4.3 Calibration linearity depends upon pavement characteristics. During procedure development, the area of a 50 ml pour was chosen as a maximum calibration area because of the following findings:

4.3.1 Larger pour areas could be measured as the sum of smaller areas by the application of analytical geometry.

4.3.2 Calibration linearity is excellent (typically r^2 = 0.999+), allowing confident extrapolation for even the largest spills ~~reported in the API study~~.

4.3.3 A set of three calibration set pours (for a total of 300 ml) adds only 0.50 pounds, or 0.060%, to the estimated typical monthly spill volume at a dispensing facility with a throughput of 200,000 gallons per month.

4.5 In principle, it is possible to perform a cross-calibration between gasoline and some less hazardous liquid, such as water. If this can be demonstrated in practice, to the satisfaction of the ~~ARB~~ Executive Officer, then water may be used for spill calibration at a test site.

5. EQUIPMENT

5.1 Field Data Forms. Use the Calibration Form and Field Data Sheet to record data during the test.

5.1.1 An example of the Calibration Form is shown in Form 1.
5.1.2 An example of the Field Data Sheet is shown in Form 2.

5.2 Graduated Cylinders. Use gasoline resistant, non-breakable graduated cylinders with maximum capacities of 10, 25 and 100 ml to conduct the spill volume versus spill area portion of the test.

5.3 Blotting Paper. Use paper that will show the outline of a gasoline spill.

5.4 Non-Sparking Tape Measure. Use a non-sparking tape measure to quantify the size of the spill areas and the height specified in Section 6.2.2.

5.5 Gasoline Can. Use an approved gasoline can of at least one (1.0) gallon capacity and equipped with a vapor tight cap.

5.6 Absorbent Substance. Any absorbent substance suitable for use with gasoline, and a safe, vapor tight disposal container.

5.7 Dust Pan and Wisk Broom. Use a dust pan and wisk broom to clean up the absorbent/gasoline after the calibration pours.

5.8 Clipboards and Indelible pens. Use a clipboard and indelible pens to record data during the test.

5.9 Planimeter. A planimeter may be used to determine the surface area of a spill if blotting paper is employed to obtain an outline of a spill.

5.10 Stopwatch. Use a stopwatch accurate to within 0.2 seconds to ~~measure~~determine the dispensing rate.

6. PRE-TEST PROCEDURES

6.1 Standard Calibration Procedure

6.1.1 For every applicable dispensing facility, select an average spill observation location to be used for developing the Spill Volume versus Spill Size calibration curve. Choose a spot on the pavement where the majority of vehicle spills occur, or a spot that is very similar (in smoothness, porosity, amount of gasoline stains, exposure to sun) to the pavement where the majority of vehicle spills occur. If one or more refueling locations have surface conditions considerably different than the calibration pour refueling point, such as stained with diesel fuel, these locations shall not be used for observations unless a specific Spill Volume versus Spill Size calibration curve is developed.

6.1.2 At the selected average spill observation location, using the procedures from sections 6.2 and 6.3, measure and record the spill area of the following eight (8) volumes of gasoline spilled from a height of 30 inches (± 2 inches):

(a)	1.0 ml	(e)	5.0 ml
(b)	2.0 ml	(f)	10.0 ml
(c)	3.0 ml	(g)	25.0 ml
(d)	4.0 ml	(h)	50.0 ml

6.1.3 Repeat the procedure from Section 6.1.2 two additional times and record the results. Calculate and record the average spill size for each of the eight (8) different spill volumes.

6.1.4 Use the absorbent substance to absorb the gasoline spilled during the development of the calibration curve. Use the wisk broom and dust pan to place the spent absorbent into the vapor tight disposal container. This material shall be disposed of in a manner consistent with applicable regulations.

6.1.~~3~~5 Construct a calibration curve for the spill observation location as described in Section~~ 8-2~~8.2. As an alternate approach, an equation may be developed to express spill volume as a function of spill area, with prior written approval of the Executive Officer. Approval of any such equation(s) will be based on the correlation coefficient of each of the eight calibration data sets (Average Spill Volume, Average Spill Area).

6.2 Pouring Procedure

6.2.1 As required in ~~s~~Section 6.1, pour 1 ml, 2 ml, 3 ml, 4 ml, 5 ml, 10 ml, 25 ml, and 50 ml of gasoline ~~(from the 100 ml graduated cylinder)~~ into the appropriate graduated cylinder. (For the 1 ml through 10 ml pours, use the 10 ml graduated cylinder, for the 25 ml pours, use the 25 ml graduated cylinder, and for the 50 ml pours use the 100 ml graduated cylinder).

6.2.2 Using the tape measure, locate a point 30 ± 2 inches above the pavement.

6.2.3 Carefully pour the gasoline from the 30 inch height onto one spot. Note that the pour shall be as close to a circular or elliptical shape as possible.

6.3 Measuring Procedure

6.3.1 In order to measure the area of the pour accurately and consistently, the tester must recognize the four phases of a pour:

(a) The pour will spread, increasing in area at a relatively rapid speed.
(b) The rate of spread will decrease.
(c) The area will stabilize.
(d) Evaporation will cause the pour to shrink.

6.3.2 The measurement shall occur at phase (c), the point at which the area of the pour is no longer increasing, but not yet decreasing:

6.3.3 Using the tape measure, measure the major axis or height (A) and minor axis or width (B) of the pour.

6.3.4 Record the dimensions on the Calibration Form, an example of which is provided in Form 1. If the pour is in the shape of an ellipse or a circle, use the geometric formula for an ellipse (A x B x 0.785) to calculate the area. If the pour does not resemble an ellipse or circle, abort the procedure and pour again.

6.3.5 For the 5 ml, 10 ml, 25 ml, and 50 ml pours, use absorbent substance (and safe, vapor tight disposal container) to absorb the gasoline and clean it up with the whisk broom and dust pan.

6.3.6 Repeat the procedure until the required data has been collected three pours each of 1 ml, 2 ml, 3 ml, 4 ml, 5 ml, 10 ml, 25 ml, and 50 ml.

6.4 Calculating Areas

6.4.1 Calculate the average area of the three 1ml pours by adding the areas and dividing that sum by three.

6.4.2 Enter this amount in the appropriate space on the Calibration Form.

6.4.3 Repeat this procedure for pours of 2 ml, 3 ml, 4 ml, 5 ml, 10 ml, 25 ml, and 50 ml.

6.4.~~5~~4 Inspect all the vapor recovery equipment that shall be used in the test. Verify that the equipment is in good working order, is free from tears, slits, leaks or any other defects which would impair the effectiveness of the system, ~~as specified in subsections (d) or (e) of Section 41960.2 of the California Health & Safety Code~~ pursuant to title 17, CCR, section 94006. Any refueling point that contains a defect of hanging hardware shall not be used during the procedure.

7. TEST PROCEDURE

7.1 Assign a Survey ID # to each vehicle included in the test. Measure and record the dimensions of all observed spills that occur during each episode of dispensing liquid into a vehicle. Drips shall be counted and entered on the Field Data Sheet (Form 2), specifying that the units of the numerical value is drops. For the purpose of this procedure, a dispensing episode includes:

7.1.1 **Pre-Fueling Spillage**. This includes removal of the nozzle from the pump through insertion of the nozzle spout into the fillpipe. Measure and record the quantity of pre-fueling spillage on the Field Data Sheet.

7.1.2 **Fueling Spillage**. This includes any spillage that occurs during dispensing of gasoline liquid into the vehicle, prior to activation of the nozzle's primary shutoff mechanism. Measure and record the quantity of fueling spillage on the Field Data Sheet.

7.1.3 **Spitback**. This is the forcible ejection of liquid gasoline upon activation of the nozzle's primary shutoff mechanism. Measure and record the quantity of spitback on the Field Data Sheet.

7.1.4 **Post-Fueling Spillage**. This includes removal of the nozzle from the vehicle through proper mounting of the nozzle on the dispenser. Measure and record the quantity of post-fueling spillage on the Field Data Sheet.

7.2 Select a vehicle for observation by choosing the next vehicle that appears, for which the refueling event is about to begin. Use the stopwatch to determine the dispensing rate during the refueling event.

7.3 Measure any spill(s) that occur. If the spillage is in the form of drops of gasoline, count and record the number of drops. If the spill is to be determined by measuring the spill area, the measurement shall occur at the point at which the area of the spill is no longer increasing, but not yet decreasing. Ensure that any quantity recorded in units of "drops" is appropriately labeled on the Field Data Sheet.

7.4 For spills on the pavement that cannot be quantified by counting drops, apply the principles of analytical geometry to measure appropriate lengths and calculate the area for each spill. e.g.:

7.4.1 If the spill resembles an **ellipse**, measure and record the major and minor axes (A & B; A = B for a circle.).

$$\text{area}_{\text{ellipse}} = \left(\frac{\pi}{4}\right)(A)(B)$$

7.4.2 If the spill resembles a rectangle, measure and record the distances between sides (W & H; W = H for a square.).

$$area_{rec} = (W)(H)$$

7.4.3 If the spill does not resemble an ellipse, circle, or a rectangle, apply the appropriate principles of analytical geometry for the shape the spill most resembles (e.g. trapezoid, polygon, etc.).

7.4.4 If the principles of analytical geometry cannot be employed, apply mensuration to parallel thin strips of equal width which are imagined to lie over the spill. For each strip, measure the length between the two points on the perimeter of the spill which are on the mid-line of each strip. The area of each strip is calculated as a rectangular area. The area of the spill is then the sum of the areas of the strips.

7.4.5 Paper may be used to obtain an outline of a spill, with prior approval of the Executive Officer. Indelible pens should be used to permanently trace the outline of the spill on the paper. If this methodology is employed, a calibrated planimeter may be used to quantify the surface area with the boundaries of the spill outline.

7.5 Spills on a Vehicle. Record any spills that land on a vehicle. All such spills shall be presumed to have an average volume of 2 ml, unless blotting paper was used to obtain the area of the spill.

7.6 Record the spill dimensions on the Field Data Sheet~~, an example of which is provided in Form 2,~~ and make a note of the shape of the spill.

7.7 Complete the measurement, calculation, and recording of all data prior to initiating the next refueling observation.

7.8 The following data shall also be recorded for each refueling event included as an observation.

7.8.1 Record the time (hours:minutes) that dispensing of gasoline begins; i.e. when the nozzle is inserted into the vehicle fill pipe.

7.8.2 Record the orientation of the nozzle in the vehicle, using 12:00 o'clock for the nozzle handle ~~spout in the vertical position~~ pointed downward and 6:00 o'clock for the nozzle handle pointed ~~downward~~upward. See Figure 2 for nozzle orientation.

7.8.3 Record the make, model, and year of the vehicle.

7.8.4 Record the time that dispensing of gasoline ends; i.e. when the nozzle is removed from the vehicle fill pipe and returned to the pump.

7.8.5 Record the number of gallons dispensed and:

(a) whether a fill-up occurred,
(b) whether a top-off occurred, and
(c) the number of shut-off clicks.
(d) the time, in seconds, for the refueling event.

7.8.6 Record the spillage type.

(a) Pre-Fueling
(b) Fueling
(c) Spitback
(d) Post-Fueling

7.8.8 Record any comments pertinent to any spillage event.

8. POST-TEST PROCEDURES

8.1 Record calibration data as indicated on the Calibration Form (Form 1). Record observations as indicated on the Field Data Sheet (Form 2).

8.2 If the Calibration Graph (Figure 1), or empirical equation, was not completed prior to conducting the testing, complete the Calibration Graph as follows.

8.2.1 Find the average spill areas of the three pours of 1.0 ml, 2.0 ml, 3.0 ml, 4.0 ml, 5.0 ml, 10 ml, 25.0 ml, and 50 ml on the Calibration Form.

8.2.2 Calculate the natural logarithms of the volumes of 1.0 ml, 2.0 ml, 3.0 ml, 4.0 ml, 5.0 ml, 10 ml, 25.0 ml, and 50 ml.

8.2.3 Plot the natural logarithms of the average spill areas against the natural logs of the volumes on the Calibration Form. An example of a Calibration Graph is shown in Figure 1.

8.3 Record any unusual aspects of any spill which could qualify such spill as resulting from inappropriate use of the system equipment. If the ~~ARB~~ Executive Officer determines that a spill resulted from inappropriate use of the system equipment, then record the spill but exclude the results of that spill from calculations below.

9. CALCULATING RESULTS

9.1 Except for the portion of a spill event quantified as the number of drops, ~~C~~calculate the spill area for each refueling event using the principles of analytical geometry, as follows.

9.1.1 If the spill resembles an **ellipse**, measure and record the major and minor axes (A & B; A = B for a circle.).

$$area_{ellipse} = \left(\frac{\pi}{4}\right)(A)(B)$$

9.2.2 If the spill resembles a rectangle, measure and record the distances between sides (W & H; W = H for a square.).

$$area_{rec} = (W)(H)$$

9.2 Convert the spill areas to spill volumes, in milliliters, using the Calibration Graph or equation derived from the calibration data. For those spills that were quantified as drops, use a conversion of 20 drops of gasoline per milliliter.

9.3 Calculate the total gallons of gasoline dispensed under each of the following three scenarios:

9.3.1 All refueling events that did not include any topoffs.

9.3.2 All refueling events ended by the activation of the nozzle's primary shutoff mechanism.

9.3.3 All refueling events not ended by the activation of the nozzle's primary shutoff mechanism.

9.3.4 All refueling events, including events terminated by topoffs.

9.4 Calculate the total pounds of gasoline spillage for each of the scenarios listed in the subsections of Section 9.3, as follows:

$$M_{spill} = \sum_{i=1}^{i=n} (V_i)\left(\frac{1}{3{,}785}\right)(6.28)$$ **Equation 9-4**

Where:

M_{spill} = Mass of spillage, pounds
V_i = Spill Volume, milliliters
6.28 = Specific Weight of liquid gasoline, pounds/gallon <u>(unless otherwise specified by CARB)</u>
3,785 = Conversion from milliliters to gallons

9.5 Calculate the mass emission factor of gasoline spillage for each of the scenarios listed in the subsections of Section 9.3, as follows:

$$E_{spill} = (1{,}000)\left(\frac{M}{G}\right)$$ **Equation 9-5**

Where:

E_{spill} = Mass emission factor for a specified refueling scenario, pounds/1,000 gallons
M_{Total} = Total mass of spillage for a specified refueling scenario, pounds
G_{Total} = Total gallons dispensed for a specified refueling scenario, gallons

10. REPORTING RESULTS

10.1 Reporting the results of the quantification of spillage shall include:

10.1.1 All calibration data establishing the relationship between Spill Volume and Spill Area.

10.1.2 Mass Emission Factor for gasoline spillage, in units of pounds/1,000 gallons, for each of the scenarios listed in under Section 9-3.

11. ALTERNATE PROCEDURES

11.1 This procedure shall be conducted as specified. Modifications to this test procedure shall not be used to determine compliance unless prior written approval has been obtained from the ARB Executive Officer, pursuant to Section 14 of Certification Procedure CP-201.

Form 1

Calibration Form

Station Name:	Date
Address:	
Equipment Tested:	
ARB Test Monitor & Tester:	

SPILL CALIBRATION					
SPILL VOLUME		SPILL DIMENSIONS		SPILL AREA	AVERAGE SPILL AREA
Height	(ml)	A (inches)	B (inches)	AB x 0.785 (sq. in.)	(sq. in.)

Form 2
Spillage Field Data Sheet

Facility:	Test Date:	Tester(s):
Address:	Phase II Equipment Type:	

Survey ID #										
Vehicle Information										
Year										
Make										
Model										
Refueling Information										
Time Start										
Nozzle Position [1 - 12 O'clock]										
Fillup ? [Y or N]										
Handheld ? [Y or N]										
Gallons Pumped										
Fueling Time, seconds										
# of Topoffs After Auto Shutoff										
SPILLAGE DATA										
Pre-Fueling Spill Dimensions										
Pre-Fueling Spill Area										
Pre-Fueling, [ml or drops]										
Fueling Spill Dimensions										
Fueling Spill Area										
Fueling, [ml or drops]										
Spitback Spill Dimensions										
Spitback Spill Area										
Spitback, [ml or drops]										
Post-Fueling Spill Dimensions										
Post-Fueling Spill Area										
Post-Fueling, [ml or drops]										
TOTAL SPILLAGE, ml										
Comments										

Figure 1

Calibration Graph

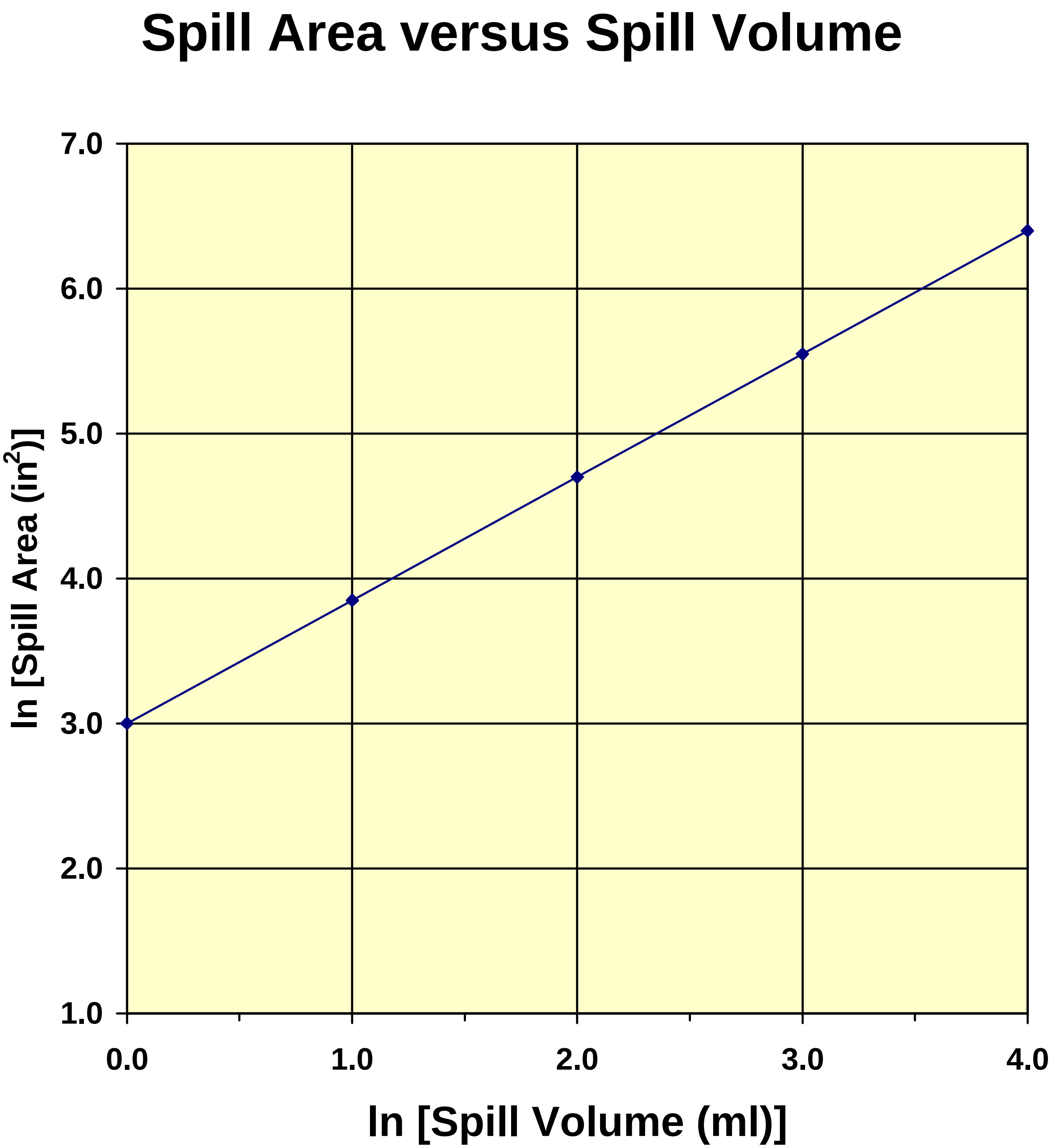
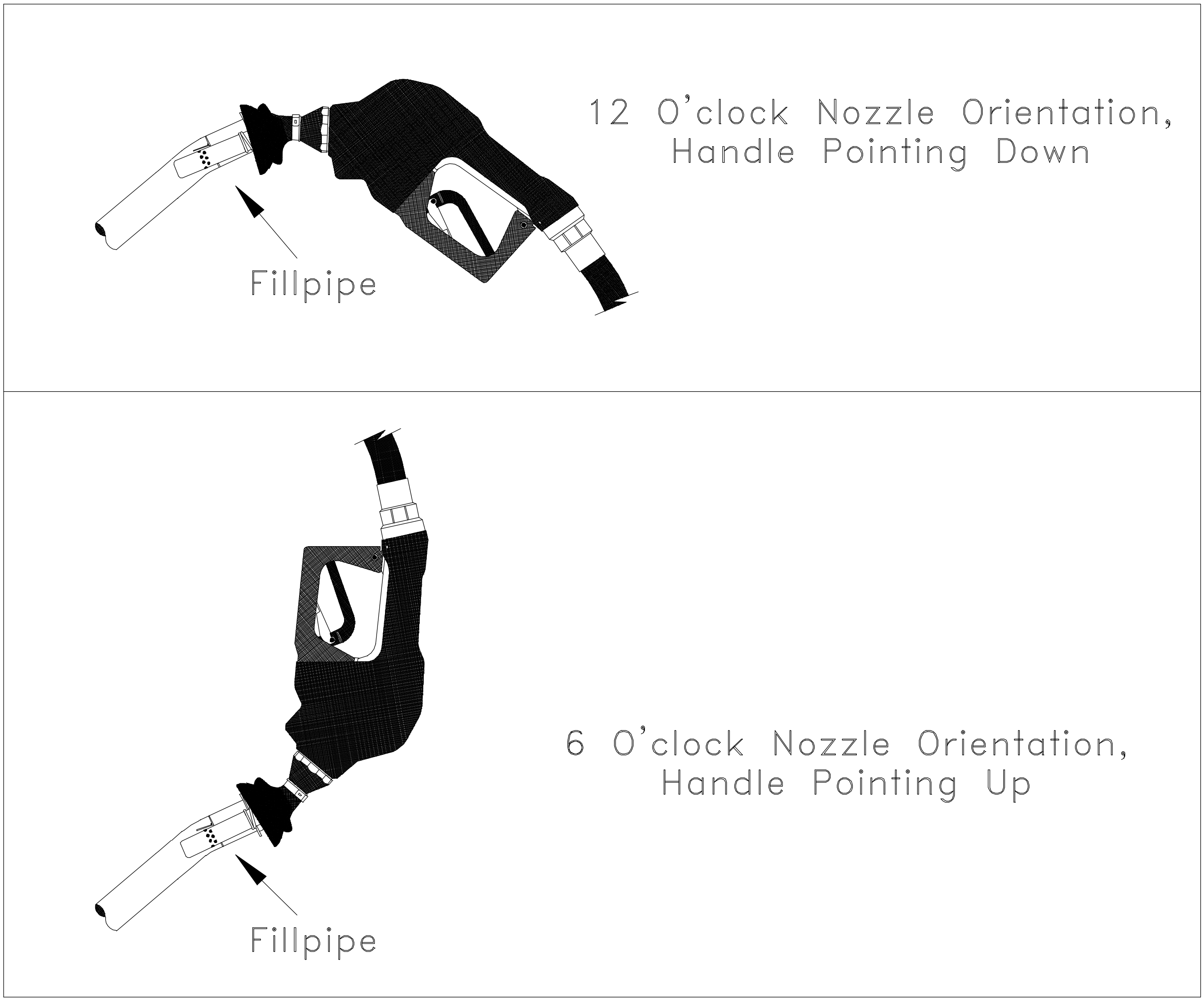


Figure 2

Nozzle Orientations



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