ARTICLE 9.
TEST METHODS

4-9-300. Test Method; Threshold Friction Velocity

A. Threshold friction velocity ("TFV") constitutes a measure of surface erodability. Assessment of TFV under this rule shall utilize a field-sieving procedure and a mathematical adjustment based on a quantitative assessment of non-erodible geologic elements that may be present.

B. Step 1. Obtain and stack a set of sieves with the following openings:
   1. 4 millimeters (mm); Tyler Sieve No. 5; ASTM 11 Sieve No. 5.
   2. 2 mm; Tyler Sieve No. 9; ASTM 11 Sieve No. 10.
   3. 1 mm; Tyler Sieve No. 16; ASTM 11 Sieve No. 18.
   4. 0.5 mm; Tyler Sieve No. 32; ASTM 11 Sieve No. 35.
   5. 0.25 mm; Tyler Sieve No. 60; ASTM 11 Sieve No. 60.
   6. A collector pan.
   7. A cover.

C. Step 2. Stack the sieves and pan in size-order, with the largest openings at the top and the pan at the bottom. Collect a sample of loose surface material from an area at least 30 centimeters (cm) by 30 cm to a depth of approximately 1 cm using a brush and dustpan or other similar device. Only collect soil samples from dry surfaces (i.e. when the surface is not damp to the touch). Remove any rocks larger than 1 cm in diameter from the sample. Carefully pour the ample into the top sieve (4 mm opening), minimizing escape of particles from the sample. Cover the sieve-stack with the lid.

D. Step 3. Manually swing the sieve-stack in a broad, circular pattern in a horizontal plane. Move the sieve-stack at a speed just necessary to audibly verify some relative horizontal motion of the sample within the sieve-stack. Complete twenty circular sweeps, ten clockwise and ten counter-clockwise. Remove the lid and un-stack the sieves in decreasing size-order. As each sieve is removed, examine the screen for loose particles. If loose particles have not been sifted to the finest sieve through which they can pass, reassemble the sieve-stack and cover and rotate the stack through an additional ten sweeps, five clockwise and five counter-clockwise. After disassembling the sieve-stack, slightly tilt and gently tap each sieve and the collector pan so that the material collects along one side. In so doing, minimize escape of particles into the air.

E. Step 5. Line up the sieves and the pan and visually inspect the collected material to assess the relative volumes of material in each. If visual inspection is not sufficient to distinguish the relative volumes, pour the respective contents into a graduated cylinder to precisely measure the volume in each sieve and pan.

F. Step 6. Identify the sieve or pan with the greatest volumetric catch, and define an initial TFV according to the following correlation: 4 mm sieve - 135 cm/sec.; 2 mm sieve - 100 cm/sec.; 1 mm sieve - 76 cm/sec.; 0.5 mm sieve - 58 cm/sec.; 0.25 mm sieve - 43 cm/sec.; collector pan - 30 cm./sec.

G. Step 7. Quantify an average TFV for the affected area. Repeat steps 1 through 6 for two other respresentative sites within the affected area, and arithmetically average the three TFV values to define an average initial TFV.

H. Step 8. Adjust the TFV to correct for non-erodible elements. Non-erodible elements are distinct elements in the random portion of the overall conditions of the affected area that are larger than 1 cm in diameter, remain firmly in place during a wind episode, and inhibit soil loss by consuming part of the shear stress of the wind. Non-erodible elements include stones and bulk surface material but do not include flat or standing vegetation.

I. Step 9. Select and mark off a 1 meter by 1 meter survey area that represents the general rock distribution on the surface. For these purposes, non-erodible, non-vegetative matter qualifies as "rock." Without moving any of the surface material, visually assess the surface to determine whether rocks larger than 1 cm (3/8 inch) are present. If the rocks are of relatively consistent dimension, count the number of rocks in the survey area. If the size of the rocks differs substantially, define small, medium and large size categories and count the number of rocks in each category.

J. Step 10. Remove one or two representative rocks from each size category (if necessary), and measure the length and width of each. Calculate an area for each size category (if necessary) based on the measured length and width.

K. Step 11. Calculate an aggregate area for each size category (if necessary), based on the number of rocks and measured representative individual rock-area. If multiple size categories were defined, total the aggregate areas for the categories. Divide the calculated aggregate area by two, and then divide that product by the area of the original sample area to calculate a %-coverage. For example, within a 1-meter (100 cm) square sample area, 250 rocks with a 1 cm x 1.5 cm length/width produces a coverage of 250 x 1 x 1.5 / 2 /(100 x 100) = 1.88% coverage.

L. Step 12. Quantify an average coverage for non-erodible elements within the overall affected area. Repeat steps 8 through 11 for two other sites within the affected area, and arithmetically average the three coverage values to define an average non-erodible area coverage.

M. Step 13. Based on the calculated average coverage by non-erodible elements, select a TFV correction factor according to the following correlation: non-erodible element coverage > 10% - correction factor = 5; non-erodible element coverage < 10% but > 5% - correction factor = 3; non-erodible element coverage < 5% but > 1% - correction factor = 2; non-erodible element coverage < 1% - correction factor = 1.

N. Step 14. Using the initial average TFV value from Step 7, multiply by the TFV correction factor from Step 13 to calculate a representative TFV for the site.

[Adopted effective September 10, 2008.]

4-9-320. Test Methods for Stabilization For Unpaved Roads and Unpaved Parking Lots

A. For Unpaved Roads and Unpaved Parking Lots

1. Silt Content Test Method. The purpose of this test method is to estimate the silt content of the trafficked parts of unpaved roads and unpaved parking lots. The higher the silt content, the more fine dust particles that are released when cars and trucks drive on unpaved roads and unpaved parking lots.

   a. Equipment:

i. A set of sieves with the following openings: 4 millimeters (mm), 2 mm, 1mm, 0.5 mm and 0.25 mm (or a set of standard/commonly available sieves), a lid, and a collector pan.

ii. A small whisk broom or paintbrush with stiff bristles and dustpan 1 ft. in width (The broom/brush should preferably have one, thin row of bristles no longer than 1.5 inches in length).

iii. A spatula without holes.

iv. A small scale with half-ounce increments (e.g. postal/package scale).

v. A shallow, lightweight container (e.g. plastic storage container).

vi. A sturdy cardboard box or other rigid object with a level surface.

vii. A basic calculator.

viii. Cloth gloves (optional for handling metal sieves on hot, sunny days).

ix. Sealable plastic bags (if sending samples to a laboratory).

x. A pencil/pen and paper.

b. Step 1 *[-Test Site Selection; Sample Collection]*: Look for a routinely traveled surface, as evidenced by tire tracks. [Only collect samples from surfaces that are not damp due to precipitation or dew. This statement is not meant to be a standard in itself for dampness where watering is being used as a control measure. It is only intended to ensure that surface testing is done in a representative manner.] Use caution when taking samples to ensure personal safety with respect to passing vehicles. Gently press the edge of a dustpan (1 foot in width) into the surface four times to mark an area that is 1 square foot. Collect a sample of loose surface material using a whiskbroom or brush and slowly sweep the material into the dustpan, minimizing escape of dust particles. Use a spatula to lift heavier elements such as gravel. Only collect dirt/gravel to an approximate depth of 3/8 inch or 1 cm in the 1 square foot area. If you reach a hard, underlying subsurface that is < 3/8 inch in depth, do not continue collecting the sample by digging into the hard surface. In other words, you are only collecting a surface sample of loose material down to 1 cm. In order to confirm that samples are collected to 1 cm in depth, a wooden dowel or other similar narrow object at least one foot in length can be laid horizontally across the survey area while a metric ruler is held perpendicular to the dowel.

- At this point, you can choose to place the sample collected into a plastic bag or container and take it to an independent laboratory for silt content analysis. A reference to the procedure the laboratory is required to follow is at the end of this section.

c. Step 2 *[- Sample Weighing]*: Place a scale on a level surface. Place a lightweight container on the scale. Zero the scale with the weight of the empty container on it. Transfer the entire sample collected in the dustpan to the container, minimizing escape of dust particles. Weigh the sample and record its weight.

d. Step 3 *[- Equipment Configuration]*: Stack a set of sieves in order according to the size openings specified above, beginning with the largest size opening (4 mm) at the top. Place a collector pan underneath the bottom (0.25 mm) sieve.

e. Step 4 *[- Sample Processing #1]*: Carefully pour the sample into the sieve stack, minimizing escape of dust particles by slowly brushing material into the stack with a whiskbroom or brush. (On windy days, use the trunk or door of a car as a wind barricade.) Cover the stack with a lid. Lift up the sieve stack and shake it vigorously up, down and sideways for at least 1 minute.

f. Step 5 *[- Sample Processing #2]*: Remove the lid from the stack and disassemble each sieve separately, beginning with the top sieve. As you remove each sieve, examine it to make sure that all of the material has been sifted to the finest sieve through which it can pass (e.g., material in each sieve [besides the top sieve that captures a range of larger elements] should look the same size). If this is not the case, re-stack the sieves and collector pan, cover the stack with the lid, and shake it again for at least 1 minute. (You only need to reassemble the sieve(s) that contain material, which requires further sifting.)

g. Step 6 *[- Weighing Collector Pan Material]*: After disassembling the sieves and collector pan, slowly sweep the material from the collector pan into the empty container originally used to collect and weigh the entire sample. Take care to minimize escape of dust particles. You do not need to do anything with material captured in the sieves; only the collector pan. Weigh the container with the material from the collector pan and record its weight.

h. Step 7 *[- Silt Loading and Silt Content Calculation]*: If the source is an unpaved road, multiply the resulting weight by 0.38. If the source is an unpaved parking lot, multiply the resulting weight by 0.55. The resulting number is the estimated silt loading. Then, divide by the total weight of the sample you recorded earlier in Step 2 and multiply by 100 to estimate the percent silt content.

i. Step 8 *[- Characterization Across Entire Site]*: Select another two routinely traveled portions of the unpaved road or unpaved parking lot and repeat this test method. Once you have calculated the silt loading and percent silt content of the 3 samples collected, average your results together.

j. Step 9: Examine Results. If the average silt loading is less than 0.33 oz/ft^2, the surface is STABLE. If the average silt loading is greater than or equal to 0.33 oz/ft^2, then proceed to examine the average percent silt content. If the source is an unpaved road and the average percent silt content is 6% or less, the surface is STABLE. If the source is an unpaved parking lot and the average percent silt content is 8% or less, the surface is STABLE. If your field test results are within 2% of the standard (for example, 4%–8% silt content on an unpaved road), it is recommended that you collect 3 additional samples from the source according to Step 1 and take them to an independent laboratory for silt content analysis.

k. Independent Laboratory Analysis: You may choose to collect 3 samples from the source, according to Step 1 and send them to an independent laboratory for silt content analysis rather than conduct the sieve field procedure. If so, the test method the laboratory is required to use is:

- U.S. Environmental Protection Agency (1995), "Procedures for Laboratory Analysis of Surface/Bulk Dust Loading Samples", (AP-42 Fifth Edition, Volume I, Appendix C.2.3 "Silt Analysis"), Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

B. Stabilization Limitations for Open Areas and Vacant Lots: The test methods described below shall be used to determine whether an open area or a vacant lot has a stabilized surface. Should a disturbed open area or vacant lot contain more than one type of disturbance, soil, vegetation, or other characteristics, which are visibly distinguishable, test each representative surface separately for stability, in an area that represents a random portion of the overall disturbed conditions of the site, according to the appropriate test methods described below, and include or eliminate it from the total size assessment of disturbed surface area(s) depending upon test method results.

1. Visible Crust Determination *[- The "Drop Ball Test"]*.

a. *[Appropriate Testing Conditions]* Where a visible crust exists, drop a steel ball with a diameter of 15.9 millimeters (0.625 inches) and a mass ranging from 16-17 grams (0.56-0.60 ounce) from a distance of **30 centimeters (**one foot**)** directly above (at a 90° angle perpendicular to) the soil surface. If blowsand is present, clear the blowsand from the surfaces on which Drop Ball Test is conducted. Blowsand is defined as thin deposits of loose uncombined grains covering less than 50% of a vacant lot which have not originated from the representative vacant lot surface being tested. If material covers a visible crust, which is not blowsand, apply the Threshold Friction Velocity determination of §B.2 of this rule to the loose material to determine whether the surface is stabilized.

b. *[Definition of Sufficient Crust]* A sufficient crust is defined under the following conditions: once a ball has been dropped according to the Appropriate Testing Conditions of §B.1.a, the ball does not sink into the surface, so that it is partially or fully surrounded by loose grains and, upon removing the ball, the surface upon which it fell has not been pulverized, so that loose grains are visible.

c. *[Characterization of Crust Across Entire Site]* Drop the ball three times within a survey area that measures 1 foot by 1 foot and that represents a random portion of the overall disturbed conditions at the site. The survey area shall be considered to have passed the Visible Crust Determination Test if at least two out of the three times that the ball was dropped, the results met the Definition of Sufficient Crust in §B.1.b. Select at least two other survey areas that represent a random portion of the overall disturbed conditions of the site, and repeat this procedure. If the results meet the Definition of Sufficient Crust in §B.1.b for all of the survey areas tested, then the site shall be considered to have passed the Visible Crust Determination Test and shall be considered sufficiently crusted.

d. *[Characterization of Crust Across Entire Site]* At any given site, the existence of a sufficient crust covering one portion of the site may not represent the existence or protectiveness of a crust on another portion of the site. Repeat the visible crust test as often as necessary on each random portion of the overall conditions of the site for an accurate measurement.

2. Determination of Threshold Friction Velocity (TFV): For disturbed surface areas that are not crusted or vegetated, determine threshold friction velocity (TFV) according to the following sieving field procedure (based on a 1952 laboratory procedure published by W. S. Chepil).

a. *[Equipment & Procedure]* Obtain and stack a set of sieves with the following openings: 4 millimeters (mm), 2 mm, 1 mm, 0.5 mm, and 0.25 mm or obtain and stack a set of standard/commonly available sieves. Place the sieves in order according to size openings, beginning with the largest size opening at the top. Place a collector pan underneath the bottom (0.25 mm) sieve. Collect a sample of loose surface material from an area at least 30 cm by 30 cm in size to a depth of approximately 1 cm using a brush and dustpan or other similar device. Only collect soil samples from dry surfaces (i.e. when the surface is not damp to the touch). Remove any rocks larger than 1 cm in diameter from the sample. Pour the sample into the top sieve (4 mm opening) and cover the sieve/collector pan unit with a lid. Minimize escape of particles into the air when transferring surface soil into the sieve/collector pan unit. Move the covered sieve/collector pan unit by hand using a broad, circular arm motion in the horizontal plane. Complete twenty circular arm movements, ten clockwise and ten counter-clockwise, at a speed just necessary to achieve some relative horizontal motion between the sieves and the particles. Remove the lid from the sieve/collector pan unit and disassemble each sieve separately beginning with the largest sieve. As each sieve is removed, examine it for loose particles. If loose particles have not been sifted to the finest sieve through which they can pass, reassemble and cover the sieve/collector pan unit and gently rotate it an additional ten times. After disassembling the sieve/collector pan unit, slightly tilt and gently tap each sieve and the collector pan so that material aligns along one side. In doing so, minimize escape of particles into the air. Line up the sieves and collector pan in a row and visibly inspect the relative quantities of catch in order to determine which sieve (or whether the collector pan) contains the greatest volume of material. If a visual determination of relative volumes of catch among sieves is difficult, use a graduated cylinder to measure the volume. Estimate TFV for the sieve catch with the greatest volume using Table 1, which provides a correlation between sieve opening size and TFV.

Table 1. Determination of Threshold Friction Velocity

Tyler Sieve No.	ASTM 11 Sieve No.	Opening (mm)	TFV (cm/s)
5	5	5	135
9	10	2	100
16	18	1	76
32	35	0.5	58
60	60	0.25	43
Collector Pan	-	-	30

b. *[Characterization of TFV Across Entire Site]* Collect at least three soil samples which represent random portions of the over-all conditions of the site, repeat the above TFV test method for each sample and average the resulting TFVs together to determine the TFV uncorrected for non-erodible elements. Non-erodible elements are distinct elements, in the random portion of the overall conditions of the site, that are larger than 1 cm in diameter, remain firmly in place during a wind episode, and inhibit soil loss by consuming part of the shear stress of the wind. Non-erodible elements include stones and bulk surface material but do not include flat or standing vegetation. For surfaces with non-erodible elements, determine corrections to the TFV by identifying the fraction of the survey area, as viewed from directly overhead, that is occupied by non-erodible elements using the following procedure. For a more detailed description of this procedure, see §B.5 - the Rock Test Method. Select a survey area of 1 meter by 1 meter that represents a random portion of the overall conditions of the site. Where many non-erodible elements lie within the survey area, separate the non-erodible elements into groups according to size. For each group, calculate the overhead area for the non-erodible elements according to the following equations:

Average Length × Average Width = Average Dimensions . ... Eq. 1

Average Dimensions × Number of Elements = Overhead Area . ... Eq. 2

Overhead Area of Group 1 + Overhead Area of Group 2 (etc.) = Total Overhead Area .. .. Eq. 3

Total Overhead Area ÷ 2 = Total Frontal Area ... ... Eq. 4

(Total Frontal Area ÷ Survey Area) × 100 = Percent Cover of Non-Erodible Elements .. .. Eq. 5

Note: Ensure consistent units of measurement (e.g., square meters or square inches) when calculating percent cover.

Repeat this procedure on an additional two distinct survey areas that represent a random portion of the overall conditions of the site and average the results. Use Table 2 to identify the correction factor for the percent cover of non-erodible elements. Multiply the TFV by the corresponding correction factor to calculate the TFV corrected for non-erodible elements.

Table 2. Correction Factors for Threshold Friction Velocity

Percent Cover of Non-Erodible Elements Factor	Correction Factor
Greater than or equal to 10%	5
Greater than or equal to 5% and less than 10%	3
Less than 5% and greater than or equal to 1%	2
Less than 1%	None

3. Determination of Flat Vegetative Cover: Flat vegetation includes attached (rooted) vegetation or unattached vegetative debris lying on the surface with a predominant horizontal orientation that is not subject to movement by wind. Flat vegetation, which is dead but firmly attached, shall be considered equally protective as live vegetation. Stones or other aggregate larger than 1 centimeter in diameter shall be considered protective cover in the course of conducting the line transect test method. Where flat vegetation exists, conduct the following line transect test method.

   a. Line Transect Test Method: Stretch a 100-foot measuring tape across a survey area that represents a random portion of the overall conditions of the site. Firmly anchor both ends of the measuring tape into the surface using a tool such as a screwdriver, with the tape stretched taut and close to the soil surface. If vegetation exists in regular rows, place the tape diagonally (at approximately a 45° angle) away from a parallel or perpendicular position to the vegetated rows. Pinpoint an area the size of a 3/32 inch diameter brazing rod or wooden dowel centered above each 1-foot interval mark along one edge of the tape. Count the number of times that flat vegetation lies directly underneath the pinpointed area at 1-foot intervals. Consistently observe the underlying surface from a 90° angle directly above each pinpoint on one side of the tape. Do not count the underlying surface as vegetated if any portion of the pinpoint extends beyond the edge of the vegetation underneath in any direction. If clumps of vegetation or vegetative debris lie underneath the pinpointed area, count the surface as vegetated, unless bare soil is visible directly below the pinpointed area. When 100 observations have been made, add together the number of times a surface was counted as vegetated. This total represents the percent of flat vegetation cover (e.g., if 35 positive counts were made, then vegetation cover is 35%). If the survey area that represents a random portion of the overall conditions of the site is too small for 100 observations, make as many observations as possible. Then multiply the count of vegetated surface areas by the appropriate conversion factor to obtain percent cover. For example, if vegetation was counted 20 times within a total of 50 observations, divide 20 by 50 and multiply by 100 to obtain a flat vegetation cover of 40%.

   b. *[Required Number of Observations]* Conduct the line transect test method, as described above, an additional two times on areas that represent a random portion of the overall conditions of the site and average results.

4. Determination of Standing Vegetative Cover: Standing vegetation includes vegetation that is attached (rooted) with a predominant vertical orientation. Standing vegetation, which is dead but firmly rooted, shall be considered equally protective as live vegetation. Conduct the following standing vegetation test method to determine if 30% cover or more exists. If the resulting percent cover is less than 30% but equal to or greater than 10%, then conduct the test in §B.2 (Determination of Threshold Friction Velocity [TFV]) in order to determine if the site is stabilized, such that the standing vegetation cover is equal to or greater than 10%, where threshold friction velocity, corrected for non-erodible elements, is equal to or greater than 43 cm/second.

   a. *[Define Survey Area]* For standing vegetation that consists of large, separate vegetative structures (e.g., shrubs and sagebrush), select a survey area that represents a random portion of the overall conditions of the site that is the shape of a square with sides equal to at least 10 times the average height of the vegetative structures. For smaller standing vegetation, select a survey area of three feet by three feet.

   b. *[Calculate Frontal Silhouette Area]* Count the number of standing vegetative structures within the survey area. Count vegetation, which grows in clumps as a single unit. Where different types of vegetation exist and/or vegetation of different height and width exists, separate the vegetative structures with similar dimensions into groups. Count the number of vegetative structures in each group within the survey area. Select an individual structure within each group that represents the average height and width of the vegetation in the group. If the structure is dense (e.g., when looking at it vertically from base to top there is little or zero open air space within its perimeter), calculate and record its frontal silhouette area, according to Equation 6. Also, use Equation 6 to estimate the average height and width of the vegetation if the survey area is larger than nine square feet. Otherwise, use the procedure in §B.4.c (Vegetative Density) to calculate the frontal silhouette area. Then calculate the percent cover of standing vegetation according to Equations 7, 8, and 9.

(Average Height) × (Average Width) = Frontal Silhouette Area .. .. Eq. 6

(Frontal Silhouette Area of Individual Vegetative Structure) × (Number of Vegetation Structures Per Group) = Frontal Silhouette Area of Group . ... Eq. 7

Frontal Silhouette Area of Group 1 + Frontal Silhouette Area of Group 2 (etc.) = Total Frontal Silhouette Area. .. .. Eq. 8

(Total Frontal Silhouette Area ÷ Survey Area) × 100 = Percent Cover of Standing Vegetation ... ... Eq. 9

[(Number of Circled Gridlines within the Outlined Area Counted that are not Covered by Vegetation ÷ Total Number of Gridline Intersections within the Outlined Area) × 100] = Percent Open Space .. . . Eq. 10

100 – Percent Open Space = Percent Vegetative Density .. .. Eq. 11

Percent Vegetative Density ÷ 100 = Vegetative Density ... . Eq. 12

[Max. Height × Max. Width] × [Vegetative Density/0.4])0.5 = Frontal Silhouette Area .. .. Eq. 13

Note: Ensure consistent units of measurement (e.g., square meters or square inches) when calculating percent cover.

c. Vegetative Density Factor: Cut a single, representative piece of vegetation (or consolidated vegetative structure) to within 1 cm of surface soil. Using a white paper grid or transparent grid over white paper, lay the vegetation flat on top of the grid (but do not apply pressure to flatten the structure). Grid boxes of 1-inch or ½-inch squares are sufficient for most vegetation when conducting this procedure. Using a marker or pencil, outline the shape of the vegetation along its outer perimeter, according to Figure B, C, or D, as appropriate. (Note: Figure C differs from Figure D primarily in that the width of vegetation in Figure C is narrow at its base and gradually broadens to its tallest height. In Figure D, the width of the vegetation generally becomes narrower from its midpoint to its tallest height.) Remove the vegetation, count and record the total number of gridline intersections within the outlined area, but do not count gridline intersections that connect with the outlined shape. There must be at least 10 gridline intersections within the outlined area and preferably more than 20, otherwise, use smaller grid boxes. Draw small circles (no greater than a 3/32 inch diameter) at each gridline intersection counted within the outlined area. Replace the vegetation on the grid within its outlined shape. From a distance of approximately 2 feet directly above the grid, observe each circled gridline intersection. Count and record the number of circled gridline intersections that are not covered by any piece of the vegetation. To calculate percent vegetative density, use Equations 10 and 11. If percent vegetative density is equal to or greater than 30, use an equation (one of the Equations 16, 17, or 18) that matches the outline used to trace the vegetation (Figure B, C, or D) to calculate its frontal silhouette area. Outline the shape of the vegetation along its outer perimeter, as either a cylinder; an inverted cone; or the upper portion of a sphere, as appropriate. For classification purposes, vegetation that generally flares with increasing height should be considered an inverted cone. Vegetation that generally narrows in width above a midpoint should be considered as the upper portion of a sphere. If percent vegetative density is less than 30, use Equations 12 and 13 to calculate the frontal silhouette area.

Figure B. Cylinder - See MaricopaAppendixC (pdf, 2132 KB), page 10, available on-line at http://yosemite.epa.gov/R9/r9sips.nsf/AgencyProvision/0A50F4E53BD113898825735B0065A8D6?OpenDocument.

Frontal Silhouette Area = Maximum Height × Maximum Width .... Eq. 16

Figure C. Inverted Cone. See MaricopaAppendixC (pdf, 2132 KB), page 11, available on-line at http://yosemite.epa.gov/R9/r9sips.nsf/AgencyProvision/0A50F4E53BD113898825735B0065A8D6?OpenDocument.

Inverted Cone Frontal Silhouette Area = Maximum Height × ½ Maximum Width .. .. Eq. 17

Figure D. Upper Sphere. See MaricopaAppendixC (pdf, 2132 KB), page 12, available on-line at http://yosemite.epa.gov/R9/r9sips.nsf/AgencyProvision/0A50F4E53BD113898825735B0065A8D6?OpenDocument.

Upper Sphere - Frontal Silhouette Area = (3.14 × Maximum Height × ½ Maximum Width) ÷ 2 ... . Eq. 18

5. Rock Test Method: The Rock Test Method examines the wind-resistance effects of rocks and other non-erodible elements on disturbed surfaces. Non-erodible elements are objects larger than 1 centimeter (cm) in diameter that remain firmly in place even on windy days. Typically, non-erodible elements include rocks, stones, glass fragments, and hard-packed clumps of soil lying on or embedded in the surface. Vegetation does not count as a non-erodible element in this method. The purpose of this test method is to estimate the percent cover of non-erodible elements on a given surface to see whether such elements take up enough space to offer protection against windblown dust. For simplification, the following test method refers to all non-erodible elements as “rocks”.

   a. *[Test Area]* Select a 1-meter × 1-meter survey area that represents the general rock distribution on the surface. (A 1-meter × 1-meter area is slightly greater than a 3-foot × 3-foot area.) Mark off the survey area by tracing a straight, visible line in the dirt along the edge of a measuring tape or by placing short ropes, yard sticks, or other straight objects in a square around the survey area.

   b. *[Initial Surface Characterization]* Without moving any of the rocks or other elements, examine the survey area. Since rocks >3/8 inch (1 cm) in diameter are of interest, measure the diameter of some of the smaller rocks to a get a sense for which rocks need to be considered.

   c. *[Grouping Characterization of Rocks]* Mentally group the rocks >3/8 inch (1 cm) diameter lying in the survey area into small, medium, and large size categories. Or, if the rocks are all approximately the same size, simply select a rock of average size and typical shape. Without removing any of the rocks from the ground, count the number of rocks in the survey area in each group and write down the resulting number.

   d. *[Determination of Average Individual Rock Area]* Without removing rocks, select one or two average-size rocks in each group and measure the length and width. Use either metric units or standard units. Using a calculator, multiply the length times the width of the rocks to get the average dimensions of the rocks in each group. Write down the results for each rock group.

e. *[Calculation of Aggregate Total Rock Area]* For each rock group, multiply the average dimensions (length times width) by the number of rocks counted in the group. Add the results from each rock group to get the total rock area within the survey area.

f. *[Calculation of Total Rock Area]* Divide the total rock area by two (to get frontal area). Divide the resulting number by the size of the survey area (making sure the units of measurement match), and multiply by 100 for percent rock cover. For example, the total rock area is 1,400 square centimeters, divide 1,400 by 2 to get 700. Divide 700 by 10,000 (the survey area is 1 meter by 1 meter, which is 100 centimeters by 100 centimeters or 10,000 square centimeters), and multiply by 100. The result is 7% rock cover. If rock measurements are made in inches, convert the survey area from meters to inches (1 inch = 2.54 centimeters).

g. *[Characterization of Rock Cover Across Entire Site]* Select and mark off two additional survey areas and repeat the procedures described above in subsections a. through f. Make sure the additional survey areas also represent the general rock distribution on the site. Average the percent cover results from all three survey areas to estimate the average percent of rock cover.

h. *[Initial Rock Cover Stabilization Determination]* If the average rock cover is greater than or equal to 10%, the surface is stable. If the average rock cover is less than 10%, follow the procedures in the following subsection i.

i. *[Combined Rock Cover/TFV Stabilization Determination]* If the average rock cover is less than 10%, the surface may or may not be stable. Follow the procedures in Subsection B.2 (Determination of Threshold Friction Velocity [TFV]) of this rule and use the results from the rock test method as a correction (i.e., multiplication) factor. If the rock cover is at least 1%, such rock cover helps to limit windblown dust. However, depending on the soil's ability to release fine dust particles into the air, the percent rock cover may or may not be sufficient enough to stabilize the surface. It is also possible that the soil itself has a high enough TFV to be stable without even accounting for rock cover.

j. *[TFV Correction Based on Partial Rock Cover]* After completing the procedures to calculate the TFV as described in the preceding subsection, use Table 2 to identify the appropriate correction factor to the TFV, depending on the percent rock cover. Multiply the correction factor by the TFV value for a final TFV estimate that is corrected for non-erodible elements.

C. TEST METHODS ADOPTED BY REFERENCE: The following test methods are adopted by reference. These adoptions by reference include no future editions or amendments.

Copies of the test methods listed in this section are available for review at Pinal County Air Quality, 31 North Pinal St., Florence, AZ 85232.

1. ASTM Method C136-06 ("Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates"), 2006 edition.

2. ASTM Method D2216-05 ("Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass"), 2005 edition.

3. ASTM Method D1557-02e1 ("Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)"), 2002 edition.

[Adopted June 3, 2009, effective August 26, 2009]

4-9-340. Visual Opacity Test Methods

A. General Provisions

1. Applicability: These methods apply to the determination of opacity of visible emissions under this Chapter 4.

2. Principle: the opacity of emissions from sources of visible emissions is determined visually by an observer qualified according to the procedures of §G of this rule.

3. Procedures: An observer qualified, in accordance with §G of this rule shall use the procedures set forth in this Article for visually determining the opacity of emissions.

B. Procedures for Determining Opacity from Emissions From Stationary Sources

1. Opacity from stationary point sources shall be determined in accord with EPA Method 9, as adopted by reference herein.

2. Adoption by Reference

The following test methods are adopted by reference. These adoptions by reference include no future editions or amendments. Copies of the test methods listed in this section are available for review at Pinal County Air Quality, 31 North Pinal St., Florence, AZ 85232.

a. EPA Reference Method 9, 40 CFR Part 60, Appendix A (7/1/08).

C. Procedures for Determining Time-Averaged Opacity from Intermittent Operations

1. *[Applicability - Intermittent Plume Average Opacity Determination for Operations]*

The purpose of this method is determine the opacity of non-continuous dust plumes caused by activities including, but not limited to, bulk material loading/unloading, non-conveyorized screening, or trenching with backhoes.

2. Opacity Determination Process

a. Position: Stand at least 25 feet from the dust-generating operation in order to provide a clear view of the emissions with the sun oriented in the 140° sector to the back. Choose a discrete portion of the operation for observation, such as the unloading point, not the whole operation. Following the above requirements, make opacity observations so that the line of vision is approximately perpendicular to the dust plume and wind direction. If multiple plumes are involved, do not include more than one plume in the line of sight at one time.

b. Initial Fallout Zone: The initial fallout zone within the plume must be identified. Record the distance from the equipment or path that is your identified initial fallout zone. The initial fallout zone is that area where the heaviest particles drop out of the entrained fugitive dust plume. Opacity readings should be taken at the maximum point of the entrained fugitive dust plume that is located outside the initial fallout zone.

c. Field Records: Note the following on an observational record sheet:

i. Location of dust-generating operation, type of operation, type of equipment in use and activity, and method of control used, if any;

ii. Observer's name, certification data and affiliation, a sketch of the observer's position relative to the dust-generating operation, and observer's estimated distance and direction to the location of the dust-generating operation;

iii. Time that readings begin, approximate wind direction, estimated wind speed, description of the sky condition (presence and color of clouds); and

iv. Color of the plume and type of background.

d. Observations. Make opacity observations, to the extent possible, using a contrasting background that is perpendicular to the line of vision. Make two observations per discrete activity, beginning with the first reading at zero seconds and the second reading at five seconds. The zero-second observation should begin immediately after a plume has been created above the surface involved. Do not look continuously at the plume but, instead, observe the plume briefly at zero seconds and then again at five seconds.

e. Recording Observations: Record the opacity observations to the nearest 5% on an observational record sheet. Each momentary observation recorded represents the average opacity of emissions for a five-second period. Repeat observations until you have recorded at least a total of 12 consecutive opacity readings. The 12 consecutive readings must be taken within the same period of observation but must not exceed one hour. Observations immediately preceding and following interrupted observations can be considered consecutive (e.g., vehicle traveled in front of path, plume doubled over).

f. Data Reduction: Average 12 consecutive opacity readings together. If the average opacity reading is equal to or less than the numerical standard in the underlying rule, the dust-generating operation is in compliance.

D. *Procedures for Determining Average Opacity from Vehicle Movement*

1. *[Applicability - Intermittent Plume Average Opacity Determination for Vehicular Movement]*. The purpose of this test method is to estimate the percent opacity of fugitive dust plumes caused by vehicle movement on unpaved roads and unpaved parking lots. This method can only be conducted by an individual who has received certification as a qualified observer. Qualification and testing requirements can be found in Section G of this Rule.

2. Opacity Determination Process

a. Step 1 *[- Position]*: Stand at least 16.5 feet from the fugitive dust source in order to provide a clear view of the emissions with the sun oriented in the 140° sector to the back. Following the above requirements, make opacity observations so that the line of vision is approximately perpendicular to the dust plume and wind direction. If multiple plumes are involved, do not include more than one plume in the line of sight at one time.

b. Step 2. *[- Field Records]*: Record the fugitive dust source location, source type, method of control used, if any, observer's name, certification data and affiliation, and a sketch of the observer's position relative to the fugitive dust source. Also, record the time, estimated distance to the fugitive dust source location, approximate wind direction, estimated wind speed, description of the sky condition (presence and color of clouds), observer's position to the fugitive dust source, and color of the plume and type of background on the visible emission observation from both when opacity readings are initiated and completed.

c. Step 3 *[- Observations]*: Make opacity observations, to the extent possible, using a contrasting background that is perpendicular to the line of vision. Make opacity observations approximately 1 meter above the surface from which the plume is generated. Note that the observation is to be made at only one visual point upon generation of a plume as opposed to visually tracking the entire length of a dust plume as it is created along a surface. Make two observations per vehicle, beginning with the first reading at zero seconds and the second reading at five seconds. The zero-second observation should begin immediately after the plume has been created above the surface involved. Do not look continuously at the plume but, instead, observe the plume briefly at zero seconds and then again at five seconds.

d. Step 4 *[- Recording Observations - #1]*: Record the opacity observations to the nearest 5% on an observational record sheet. Each momentary observation recorded represents the average opacity of emissions for a 5-second period. While it is not required by the test method, EPA recommends that the observer estimate the size of vehicles which generate dust plumes for which readings are taken (e.g. mid-size passenger car or heavy-duty truck) and the approximate speeds the vehicles are traveling when the readings are taken.

e. Step 5 *[- Recording Observations - #2]*: Repeat Step 3 and Step 4 until you have recorded a total of 12 consecutive opacity readings. This will occur once six vehicles have driven on the source in your line of observation for which you are able to take proper readings. The 12 consecutive readings must be taken within the same period of observation but must not exceed 1 hour. Observations immediately preceding and following interrupted observations can be considered consecutive.

f. Step 6 *[- Data Reduction]*: Average the 12 opacity readings together. If the average opacity reading is equal to or less than the numerical standard in the underlying rule, the source is in compliance.

E. Procedures for Determining Time-Averaged Opacity from Continuous Operations

1. *[Applicability - Continuous Plume Average Opacity Determination for Operations]*

The purpose of this method is to determine the opacity of continuous dust plumes caused by equipment and activities including but not limited to graders, trenchers, paddlewheels, blades, clearing, leveling, and raking.

2. Opacity Determination Process

a. Position: Stand at least 25 feet from the dust-generating operation to provide a clear view of the emissions with the sun oriented in the 140° sector to your back. Following the above requirements, make opacity observations so that the line of vision is approximately perpendicular to the dust plume and wind direction.

b. Dust Plume: Evaluate the dust plume generation and determine if the observations will be made from a single plume or from multiple related plumes.

i. If a single piece of equipment is observed working, then all measurements should be taken off the resultant plume as long as the equipment remains within the 140° sector to the back.

ii. If there are multiple related sources or multiple related points of emissions of dust from a particular activity, or multiple pieces of equipment operating in a confined area, opacity readings should be taken at the densest point within the discrete length of equipment travel path within the 140° sector to the back.

Readings can be taken for more than one piece of equipment within the discrete length of travel path within the 140° sector to the back.

c. Initial Fallout Zone: The initial fallout zone within the plume must be identified. Record the distance from the equipment or path that is your identified initial fallout zone. The initial fallout zone is that area where the heaviest particles drop out of the entrained fugitive dust plume. Opacity readings should be taken at the maximum point of the entrained fugitive dust plume that is located outside the initial fallout zone.

d. Field Records: Note the following on an observational record sheet:

   i. Location of the dust-generating operation, type of operation, type of equipment in use and activity, and method of control used, if any;

   ii. Observer's name, certification data and affiliation, a sketch of the observer's position relative to the dust-generating operation, and observer's estimated distance and direction to the location of the dust-generating operation; and

   iii. Time that readings begin, approximate wind direction, estimated wind speed, description of the sky condition (presence and color of clouds).

e. Observations: Make opacity observations, to the extent possible, using a contrasting background that is perpendicular to the line of vision. Make opacity observations at a point beyond the fallout zone. The observations should be made at the densest point. Observations will be made every 10 seconds until at least 12 readings have been recorded. Do not look continuously at the plume, but observe the plume momentarily at 10-second intervals. If the equipment generating the plume travels outside the field of observation or if the equipment ceases to operate, mark an "X" for the 10-second reading interval. Mark an "X" when plumes are stacked or doubled, either behind or in front, or become parallel to line of sight. Opacity readings identified as "X" shall be considered interrupted readings.

f. Recording Observations: Record the opacity observations to the nearest 5% on an observational record sheet. Each momentary observation recorded represents the average opacity of emissions for a 10-second period.

g. Data Reduction: Average 12 consecutive opacity readings together. If the average opacity reading is equal to or less than the numerical standard in the underlying rule, the dust-generating operation is in compliance.

F. Procedures for Determining the Frequency of Visible Emissions; Time Aggregation Method

1. *Applicability - Aggregate Quantification of Visible Emission Duration*

   The purpose of this method is to determine the amount of time that visible emissions occur during the observation period (*i.e.*, the accumulated emission time).

2. Adoption by Reference

   The following test methods are adopted by reference. These adoptions by reference include no future editions or amendments. Copies of the test methods listed in this section are available for review at Pinal County Air Quality, 31 North Pinal St., Florence, AZ 85232.

   a. EPA Reference Method 22 ("Visual Determination of Fugitive Emissions from Material Sources and Smoke Emissions from Flares"), 2000 edition.

G. Qualification and Testing

1. Certification Requirements: To receive certification as a qualified observer, a candidate must be tested and demonstrate the ability to assign opacity readings in 5% increments to 25 different black plumes and 25 different white plumes, with an error not to exceed 15% opacity on any one reading and an average error not to exceed 7.5% opacity in each category. Candidates shall be tested according to the procedures described in this subsection. Any smoke generator shall be equipped with a smoke meter, which meets the requirements of this subsection. Certification tests that do not meet the requirements of this subsection are not valid. The certification shall be valid for a period of 6 months, and after each 6-month period the qualification procedures must be repeated by an observer in order to retain certification.

2. Certification Procedure: The certification test consists of showing the candidate a complete run of 50 plumes, 25 black plumes and 25 white plumes, generated by a smoke generator. Plumes shall be presented in random order within each set of 25 black and 25 white plumes. The candidate assigns an opacity value to each plume and records the observation on a suitable form. At the completion of each run of 50 readings, the score of the candidate is determined. If a candidate fails to qualify, the complete run of 50 readings must be repeated in any retest. The smoke test may be administered as part of a smoke school or training program, and may be preceded by training or familiarization runs of the smoke generator, during which candidates are shown black and white plumes of known opacity.

3. Smoke Generator Specifications: Any smoke generator used for the purpose of this subsection shall be equipped with a smoke meter installed to measure opacity across the diameter of the smoke generator stack. The smoke meter output shall display in-stack opacity, based upon a path length equal to the stack exit diameter on a full 0% to 100% chart recorder scale. The smoke meter optical design and performance shall meet the specifications shown in Table 3 of

this appendix. The smoke meter shall be calibrated as prescribed in this subsection prior to conducting each smoke reading test. At the completion of each test, the zero and span drift shall be checked, and if the drift exceeds plus or minus 1% opacity, the condition shall be corrected prior to conducting any subsequent test runs. The smoke meter shall be demonstrated, at the time of installation, to meet the specifications listed in Table 3 of this appendix. This demonstration shall be repeated following any subsequent repair or replacement of the photocell or associated electronic circuitry, including the chart recorder or output meter, or every 6 months, whichever occurs first.

a. Calibration: The smoke meter is calibrated after allowing a minimum of 30 minutes warm-up by alternately producing simulated opacity of 0% and 100%. When stable response at 0% or 100% is noted, the smoke meter is adjusted to produce an output of 0% or 100%, as appropriate. This calibration shall be repeated until stable 0% and 100% readings are produced without adjustment. Simulated 0% and 100% opacity values may be produced by alternately switching the power to the light source on and off while the smoke generator is not producing smoke.

b. Smoke Meter Evaluation: The smoke meter design and performance are to be evaluated as follows:

   i. Light Source: Verify, from manufacturer's data and from voltage measurements made at the lamp, as installed, that the lamp is operated within plus or minus 5% of the nominal rated voltage.

   ii. Spectral Response of Photocell: Verify from manufacturer's data that the photocell has a photopic response (i.e., the spectral sensitivity of the cell shall closely approximate the standard spectral-luminosity curve for photopic vision which is referenced in (b) of Table 3 of this appendix).

   iii. Angle of View: Check construction geometry to ensure that the total angle of view of the smoke plume, as seen by the photocell, does not exceed 15°. Calculate the total angle of view as follows:

   $$\text{Total Angle of View} = 2 \tan^{-1} d/2L$$

   where:

   d = The photocell diameter + the diameter of the limiting aperture; and

   L = The distance from the photocell to the limiting aperture.

   The limiting aperture is the point in the path between the photocell and the smoke plume where the angle of view is most restricted. In smoke generator smoke meters, this is normally an orifice plate.

iv. Angle of Projection: Check construction geometry to ensure that the total angle of projection of the lamp on the smoke plume does not exceed 15°. Calculate the total angle of projection as follows:

Total Angle of Projection = 2 $\tan^{-1}$ d/2L

Where:

d = The sum of the length of the lamp filament + the diameter of the limiting aperture; and

L = The distance from the lamp to the limiting aperture.

v. Calibration Error: Using neutral-density filters of known opacity, check the error between the actual response and the theoretical linear response of the smoke meter. This check is accomplished by first calibrating the smoke meter, according to subsection G.3.a , and then inserting a series of three neutral-density filters of nominal opacity of 20%, 50%, and 75% in the smoke meter path length. Use filters calibrated within plus or minus 2%. Care should be taken when inserting the filters to prevent stray light from affecting the meter. Make a total of five nonconsecutive readings for each filter. The maximum opacity error on any one reading shall be plus or minus 3%.

vi. Zero and Span Drift: Determine the zero and span drift by calibrating and operating the smoke generator in a normal manner over a 1-hour period. The drift is measured by checking the zero and span at the end of this period.

vii. Response Time: Determine the response time by producing the series of five simulated 0% and 100% opacity values and observing the time required to reach stable response. Opacity values of 0% and 100% may be simulated by alternately switching the power to the light source off and on while the smoke generator is not operating.

Table 3. Smoke Meter Design and Performance Specifications

Parameter	Specification
1. Light source	Incandescent lamp operated at nominal rated voltage
2. Spectral response of photocell	Photoptic (daylight spectral response of the human eye)
Angle of view	5° maximum total angle
Angle of projection	5° maximum total angle
Calibration error	Plus or minus 3% opacity maximum
Zero and span drift	Plus or minus 1% opacity 30 minutes
3. Response time	Less than or equal to 5 seconds

[Adopted June 3, 2009, effective August 26, 2009]