

REGULATION I

CONTROL OF AIR POLLUTION FROM SMOKE AND SUSPENDED PARTICULATE MATTER

I. Purpose

It is the purpose of this Regulation to establish air standards for the State of Texas on smoke and suspended particulate matter to prevent undesirable levels of these air contaminants from occurring.

II. Definitions

- A. The section on definitions in the General Provisions of the Board's Regulations applies to this Regulation. The additional terms defined in this section have the meanings given to them herein when used in this Regulation.
- B. "Particulate Matter". Discrete particles of liquid (except uncombined water) or solid matter or both which are often, but not always, suspended in air or in other gases at atmospheric temperature and pressure. The term "suspended particulate matter" is used to distinguish such liquid or solid matter from material which settles rapidly due to gravity.
- C. "Ringelmann Smoke Chart". The Ringelmann Scale for Grading the Density of Smoke, published by the U.S. Bureau of Mines, or any chart, recorder, indicator or device for the measurement of smoke density which is approved by the Board as the equivalent of the Ringelmann Scale.
- D. "Smoke". Small gas-borne particles resulting from incomplete combustion, consisting predominantly of carbon and other combustible material, and present in sufficient quantity to be observable.

III. Smoke

- A. It has been found that control of smoke emissions is an important element in controlling and abating air pollution. Experience has proven that the adverse effects from the contribution of smoke to the atmosphere over a city or metropolitan area can be minimized if the shade or

appearance of individual emissions is not as dark as nor darker than No. 2 on the Ringelmann Smoke Chart.

B. Control of Smoke:

1. The emission of smoke from any combustion unit (other than a flare, as described in paragraph 2, below) or from any type of burning in a combustion unit (other than a flare), including the incineration of industrial, commercial and municipal wastes, shall be controlled so that the shade or appearance of the emission is not as dark as nor darker than No. 2 on the Ringelmann Smoke Chart, except that smoke emitted during the cleaning of a fire box or the building of a new fire, sootblowing, equipment changes, ash removal and rapping of precipitators may be as dark as or darker than No. 2 on the Ringelmann Smoke Chart for a period or periods aggregating not more than five minutes in any sixty consecutive minutes, nor more than six hours in any 10-day period.
2. The emission of smoke from a flare or other similar device installed before February 1, 1967, used for burning in connection with pressure valve releases and for control over process upsets shall be controlled so that the shade or appearance of the emission is not as dark as nor darker than No. 2 on the Ringelmann Smoke Chart more than an aggregate time of six hours in any 10-day period. Emissions of smoke from such a flare or similar device installed or substantially modified in design after January 31, 1967, shall not be as dark as nor darker than No. 1 on the Ringelmann Smoke Chart more than an aggregate time of six hours in any 10-day period.
3. The emission of smoke from continuous process units during periods of shut-down and start-up and during start-up of new units shall be controlled so that the shade or appearance of the emission is not as dark as nor darker than No. 2 on the Ringelmann Smoke Chart more than an aggregate time of six hours during any 24 consecutive hours, nor more than 12 hours during any 10-day period.

C. Procedures for the determination of smoke emissions shall be performed as outlined in Appendix A of this Regulation.

D. The provisions on multiple air contaminant properties,

Paragraph V.B. of the General Provisions, do not apply to this Section III.

IV. Suspended Particulate Matter

- A. The results from field surveys conducted in several regions of the State show the need in many areas to prevent an increase in the level of suspended particulate matter in the atmosphere, and in other areas, show the need to reduce the overall levels of suspended particulate matter.
- B. Ambient Air Quality Standards for Suspended Particulate Matter. The Board declares that concentrations of suspended particulate matter in the atmosphere higher than the levels specified below for the various land use areas constitute undesirable levels, whether the sources are from natural causes or from the activities of man, and that a state of air pollution exists when concentrations of suspended particulates exceed these levels. The ambient air quality for an area shall be determined on the basis of not less than ten, 24-hour samples taken within a 30-day period of time. The ambient air quality for an area is considered as having exceeded the standards stated below if the concentrations of suspended particulate matter in the ambient atmosphere of the area, based on the requisite 24-hour samples, exceed these levels more than 10% of the time.
1. Type A land use, residential and recreation - not to exceed 125 micrograms of suspended particulate matter per cubic meter of air.
 2. Type B land use, commercial and business - not to exceed 150 micrograms of suspended particulate matter per cubic meter of air.
 3. Type C land use, industrial - not to exceed 175 micrograms of suspended particulate matter per cubic meter of air.
 4. Type D land use - not to exceed 200 micrograms of suspended particulate matter per cubic meter of air.

Sampling and analyses to determine the concentration of

suspended particulate matter shall be performed in accordance with the procedures outlined in Appendix B of this Regulation.

C. Emission Limits for Suspended Particulate Matter.

To assist in meeting the ambient air quality standards specified in Paragraph IV.B. of this Regulation, the Board hereby establishes limits on the emission of suspended particulate matter which may be made from any property. The contribution of suspended particulate matter by a single property to an affected land use area shall be measured by the difference between the upwind level and the downwind level of air contaminants for the property as outlined in Appendix B, or by stack sampling calculated to a downwind concentration, in accordance with Paragraph IV.D. below and as outlined in Appendix C. If the contribution from the property, determined in accordance with the procedure in Appendix B or C, exceeds the emission limits set forth below, the property is in violation of this Regulation. A property is in compliance if the contribution from such property does not exceed the applicable limits specified in the schedule.

Micrograms of suspended particulate matter per cubic meter of air sampled

<u>Land Use Area Affected</u>	<u>Property Emission Limits</u>
Type A	100
Type B	125
Type C	150
Type D	175

D. Control of Emissions by Stack Sampling

Where stack sampling is feasible, this is the method for measuring and controlling emissions preferred by the Board. Proper and professional engineering judgment shall be the criteria for determining the method of measurement. The property owner shall, upon request of the Board, provide in connection with such stack or flue such sampling and testing facilities and sampling ports, exclusive of instruments and sensing devices, as may be necessary for the Board to determine the nature and quantity of solid particles which are or may be discharged as the result of source operations.

Such facilities may be either permanent or temporary, at the discretion of the person responsible for their provision and shall conform to all applicable laws and regulations concerning safe construction or safe practices. Evidence and data based on these stack samples and calculations may be used to substantiate compliance with or violations of this Regulation. Agents of the Board shall be permitted to sample the stacks at any reasonable time.

In situations where stack sampling is not feasible, compliance will be determined by the difference between the upwind level and the downwind level of air contaminants for the property as outlined in Appendix B. Usually, this method will be preferred if particulates are not emitted through a stack but rather through the side of the building or through roof vents or through other ground level sources. This method would also likely be the preferred method if emissions are made through a great number of flues and stacks so that measurement of such flue and stack individually is not practicable.

Nothing herein precludes the Board from using any appropriate method of measurement as circumstances may dictate.

- E. To aid in controlling the overall levels of suspended particulate matter in the atmosphere, air pollution control facilities which are installed on a property shall be used whenever emissions of particulate matter are being made which can be controlled by the facilities, even though the ambient air quality standards in affected areas are not exceeded.
- F. Exception: A portable type hot-mix asphaltic concrete plant which is equipped with a cyclone or mechanical dust collector may be operated in a Type D land use area if it is at least one mile from any Type A, B or C land use area other than a Type A, B, or C land use area located on the property on which the plant is located.
- G. The provisions on multiple air contaminant properties, Paragraph V.B. of the General Provisions, apply to this Section IV, as appropriate.

V. Provisions Governing Specific Activities

- A. Smoke or suspended particulate matter which is by its nature toxic to human or animal life or vegetation shall be controlled to more restrictive levels than is required for smoke and suspended particulate matter generally, and it shall not be emitted in such quantities or concentrations as to injure human or animal life or vegetation.

1. The concentration of beryllium at any point beyond the property on which the source thereof is located shall not exceed 0.01 micrograms per cubic meter of air based on a 24-hour sample.
- B. Burning of burrs, trash, lint and other wastes from cotton ginning operations is prohibited, except with prior approval of the Board.
- C. The emission of smoke, suspended particulate matter or uncombined water which passes onto or across a public road and creates a traffic hazard by impairment of visibility or intensifies an existing traffic hazard condition is prohibited. For purposes of this provision, a traffic hazard resulting from impairment of visibility shall be deemed to exist whenever horizontal visibility at or near ground level is reduced to 2400 feet or less in rural areas or to 1100 feet or less in urban areas, as specified by the American Association of Highway Officials "Policy of Geometric Design of Rural Highways" 1966.

VI. Exclusions from Application of this Regulation

The following matters are excluded from the application of this Regulation:

- A. Emissions of smoke or suspended particulate matter pursuant to and in compliance with the terms of a variance granted by the Board.
- B. Air conditions existing solely within the property boundaries of a commercial or industrial plant, works or shop when the source of the offending air contaminants is under the control of the person operating such plant, works or shop.
- C. Emissions of smoke or suspended particulate matter from an activity when all of the following conditions exist:
 1. the source of the emissions is in a relatively unpopulated area of the State;
 2. the source of the emissions was in operation prior to August 30, 1965, the effective date of the 1965 Clean Air Act of Texas (Chapter 687, Acts of the 59th Legislature, Regular Session, 1965), and has continued to be in operation from that date;

3. the quantity, characteristics and duration in the atmosphere of the air contaminants emitted are such that the air contaminants are not toxic to human or animal life and do not unreasonably interfere with the physical property of the people; and
4. it is not technically practicable nor economically reasonable to eliminate the emissions.

Any person claiming exclusion from the application of this Regulation under this provision shall apply to the Board through the Executive Secretary for exclusion. The applicant shall furnish such information as the Board may reasonably require to enable it to make a determination. The Board may make such determination and apply such conditions as may be appropriate to the activity in question. A person granted an exclusion under this provision may be required to furnish the Board with plans satisfactory to the Board for implementing any reasonable control measures which may be developed or which may otherwise become available.

VII. Effective Date

- A. This Regulation is effective January 3, 1968.
- B. No person may cause, suffer, allow or permit the emission of smoke or suspended particulate matter except as provided in this Regulation.

APPENDIX A

Determinations of Smoke by Use of Ringelmann Smoke Chart

USE OF CHART

Support the chart on a level with the eye, at such a distance from the observer that the lines on the chart merge into shades of gray, and as nearly as possible in line with the stack. Glance from the smoke, as it issues from the stack, to the chart and note the number on the chart most nearly corresponding with the shade of the smoke, then record this number with the time of observation. A clear stack is recorded as No. 0, and 100 percent black smoke as No. 5.

To determine average smoke emission over a relatively long period of time, such as an hour, observations are usually repeated at one-fourth or one-half minute intervals. The readings are then reduced to the total equivalent of No. 1 smoke as a standard. No. 1 smoke being considered as 20 percent dense, the percentage "density" of the smoke for the entire period of observation is obtained by the formula:

$$\frac{\text{Equivalent units of No. 1 smoke} \times 0.20}{\text{Number of observations}} = \text{percentage smoke density}$$

Further information on the Ringelmann Smoke Chart and its use may be found in the United States Department of Interior, Bureau of Mines Information Circular 7718 of August 1955. A modified Ringelmann Chart for hand use has been prepared by the Texas Air Control Board staff and may be used to determine smoke density. The chart may be obtained by writing the Executive Secretary.

Use of Modified Ringelmann Chart:

1. Hold chart at arm's length and view smoke above the grid on chart.
2. Be sure that light shining on chart is the same light that is shining on smoke being examined; for best results, sun should be behind observer.
3. Match smoke as closely as possible with corresponding grid on chart and record.
4. Proceed as outlined above.

APPENDIX B

High Volume Air Sampling

A. Determination of Ambient Air Quality

The sampling for ambient air quality shall be by high volume air samples of twenty-four hours duration. A minimum of ten air samples within a thirty-day period in the affected area shall be collected. The ambient air quality for the area is considered as having exceeded the standards outlined in Paragraph IV.B., if the 24-hour samples exceed those levels more than 10% of the time.

B. Determination of Compliance with Emission Limits

1. High volume air samplers shall be used to take upwind level samples and downwind level samples so as to determine the contribution of the property in question. Samples shall be taken away from areas of local air quality disturbances, such as dusty roads. The concentration of particulate matter in the "downwind sample" less the concentration in the "upwind sample" shall be used in determining whether the emissions from the property comply with the requirements in Section IV of this Regulation.
2. To provide adequate data to constitute proof of compliance or violation, the following minimum sampling requirements shall be met:
 - a. Duration of Sampling:
 - (1) If the measured value exceeds the emission limit by not more than $100 \mu\text{g}/\text{M}^3$, a minimum 5-hour sample shall be collected in a 24-hour period
 - (2) If the measured value exceeds the emission limit by more than 100 but less than 300 $\mu\text{g}/\text{M}^3$, a minimum 3-hour sample shall be collected in a 24-hour period
 - (3) If the measured value exceeds the emission limit by 300 $\mu\text{g}/\text{M}^3$ or more, a minimum 1-hour sample shall be collected in a 24-hour period
 - b. Individual samples shall be collected for a minimum of one hour each, unless the flow rate is reduced excessively in less than one hour due to plugging of the filter. The number of samples required to provide adequate sampling time can be collected continuously or intermittently.

- c. To provide adequate samples, each filter used for downwind sampling should contain at least 20 mg. of sample so that accurate weight measurements may be obtained.

Variations in method and procedure which will give equivalent results may be utilized if approved by the Executive Secretary.

C. Standard Procedure and Equipment for High Volume Air Sampling

1. Filter Media - Collection media shall be a fiber glass mat (filter) or other suitable media capable of trapping all suspended particulate matter 0.3 micron or larger in size, such as MSA 1106B Flash Fired, Gelman Type A, or equivalent.
2. Vacuum Pump - Air shall be drawn through this filter at a rate not to exceed 70 cubic feet per minute (cfm), nor less than 10 cfm. This unit shall have a flow meter or measuring device capable of reading true air flow.¹
3. Records

Sampling Data shall include the following:

- a. Starting and ending time and date of sample
- b. Initial flow rate and final flow rate
- c. Location of sampler
- d. Wind direction and velocity
- e. Signature and remarks of person collecting sample
- f. Temperature and atmospheric pressure during sampling period as obtainable from the nearest U.S. Weather Bureau Station

4. Weighing of Filter

Particulate weight collected shall be determined as the final weight of the filter, less the initial weight of filter.

¹True air flow - If the flow meter device does not measure true air flow, it must be calibrated against known flows and a correction curve made for these findings.

- a. Initial and final weight of the filter shall be determined to the nearest one thousandth of a gram as determined by a standard analytical balance.
- b. Initial and final weight of the filter shall be determined after the filter has been exposed to standard laboratory conditions for a period of not less than 24 hours. (This is necessary to prevent the loss or gain of water vapor entering into the net particulate weight determination.)

5. Volume of Air Sampled

Total volume of air sampled shall be determined as average rate of flow times the period of sampling. (The average rate of flow shall be determined by obtaining the arithmetic average of the initial and ending rates of flow, provided the flow does not decrease by more than one-half during the sampling period; otherwise intermittent flow readings must be taken during the sampling period to compute the arithmetic average.) This shall be expressed as total cubic meters of air sampled.

6. Calculation of Pollutant Concentration

Particulate weight collected (grams) divided by volume of air sampled in cubic meters (M^3) shall be expressed as micrograms per cubic meter ($\mu g/M^3$) of air sampled.

7. Sample Criteria

- a. Samples mutilated or damaged during collection or analysis to an extent that would affect the air flow or determination of particulate matter weight shall be discarded as unuseable.
- b. Samples shall be collected at a height of not less than 3 feet nor greater than 10 feet from ground level.
- c. Sampling surface shall be so placed or shielded so as to collect only suspended particulate matter.
- d. Insects impinged upon the filter shall not be considered suspended particulate matter and shall be removed from the determination of net particulate collected. (If this is impractical, sample

shall be discarded.)

- e. Barometric pressure and temperature correction to standard conditions may be made when such is indicated. When such correction is employed, average of hourly barometric pressure and temperatures must be used to determine the necessary corrections. Standard conditions are 14.7 lbs/square inch (29.92 inches or 760 mm of mercury) pressure and air having a density of 0.07495 lbs/cubic foot, temperature 20°C or 68°F.
- f. A constant voltage transformer of adequate capacity in the power system of the air sampler is recommended to prevent voltage fluctuations which may cause variable motor speeds and resultant variable air flow. To insure accurate elapsed time measurement, a timer switch clock may be incorporated in the circuit.

8. Calculation of total suspended particulate matter

Example:

Air Flow:

(1) Initial flow meter reading (True)	60 cfm*
(2) Final flow meter reading (True)	58 cfm
(3) Arithmetic average $\frac{(1) + (2)}{2} =$ $\frac{60\text{cfm} + 58\text{cfm}}{2} =$	59 cfm
(4) Hour began 1/16/66	0001 hrs*
(5) Hour complete 1/17/66	0001 hrs
(6) Elapse time minutes = hrs x 60'/hr = 24 hrs x 60'/hr =	1440'*
(7) Total ft ³ of air sampled = (3) x (6) = 59 cfm x 1440' =	84960 ft ³ *
(8) Total M ³ of air sampled = (7) ÷ 35.314 ft ³ /M ³ = 84960 ft ³ ÷ 35.314 M ³ =	2406 M ³ *

Suspended Particulate Matter:

(9) Filter weight after sampling in gms	4.1090 gms*
(10) Filter weight before sampling in gms	4.0090 gms
(11) TSPM* collected (9) - (10) = 4.1090 gms - 4.0090 gms =	0.1000 gms

(12)	μgms of TSPM (11) = (11) x 10^6 $\mu\text{gms}/\text{gm}$ = 0.1000 gms x 10^6 $\mu\text{gms}/\text{gm}$ =	100,000 μgm
(13)	μgms^* of TSPM per M^3 of air sampled equal (12) \div (8) = 100,000 $\mu\text{gms} \div$ 2406 M^3 =	42 $\mu\text{gm}/\text{M}^3$

* Explanation of symbols and abbreviations:

cfm - cubic feet/minute
 hr or hrs = hour or hours respectively
 ' = minute or minutes
 ft^3 = cubic feet
 M^3 = cubic meters
 gm or gms = gram or grams respectively
 μgm = micrograms (0.000001 gm)
 TSPM = total suspended particulate matter

References

Additional information on the procedures is available in:

1. "Recommended Standard Methods of Atmospheric Sampling of Fine Particulate Matter by Filter Media--High Volume Sampler APM-2.5", Journal of the Air Pollution Control Association, January 1967, Vol. 17 No. 1, pages 17-25.
2. "Recommended Standard Method for Atmospheric Sampling of Fine Particulate Matter by Filter Media--High Volume Sampler APM-2.5", Air Pollution Control Association TR-2 - Air Pollution Measurements Committee, principal authors, George A. Jutze and Kirk E. Foster, Air Pollution Control Association, 4400 Fifth Ave., Pittsburgh, Pa. 15213.

APPENDIX C

A. Stack Sampling

The amount of particulate matter emitted from a stack shall be measured according to the American Society of Mechanical Engineers "Power Test Codes - PTC - 27" dated 1957 and entitled, "Determining Dust Concentration in a Gas Stream." This publication is hereby made a part of this Regulation by reference. Compliance shall be determined on the basis of not less than two complete determinations within any 24-hour period. Any other method approved by the Executive Secretary may be used in accordance with good professional practice.

B. Calculations of Particulate Matter Concentrations from Stack Samples and Measurements

Maximum allowable stack emission rates or ground level concentrations of suspended particulate matter from measured stack emission rates shall be calculated by Sutton's equation as set forth below. This equation has been modified to provide results comparable to one-hour ambient air samples:

$$Q_a = Z \pi \bar{u} C^2 X^{2-n} 10^{-6} \exp \left[\frac{H_e^2}{C^2 X^{2-n}} \right]$$

where,

Q_a = emission rate, grams per second

Z = ground level concentration, micrograms per cubic meter

π = 3.14

\bar{u} = mean wind speed set at 3.8 meters per second

C^2 = isotropic diffusion coefficient, set at 0.010 for neutral conditions, with dimensions, m^n

X = downwind distance from source, meters

n = stability parameter, nondimensional, set at 0.25 for neutral conditions

exp = exponential function, e = 2.72

H_e = effective stack height, meters

If the stack emission contains a significant portion of large particles which fall out within the property, a correction may be made to exclude such portions from the sample weight, with the approval of the Executive Secretary.

Computation of Effective Stack Height

The effective stack height is the physical stack height plus the height that the effluent plume initially rises above the stack owing to the stack draft velocity and/or the buoyancy of the effluent. For a flue gas temperature equal to, or less, than 65°F., the effective stack height is calculated by the following equation:

$$H_e = H + d \left[\frac{V_s}{u} \right]^{1.4} \left[1 + \frac{DT}{T_s} \right]$$

where,

H_e = effective stack height, meters

H = height of stack, meters

V_s = stack gas ejection velocity, meters per second

d = internal diameter of stack top, meters

u = wind speed, meters per second (Assume 3.8 meters per second.)

DT = stack gas temperature minus ambient air temperature, °K. (Assume ambient air temperature is 293 °K.)

T_s = stack gas temperature, °K

For a flue gas greater than 65° F, the effective stack height is calculated by the following equation:

$$H_e = H + \frac{(1.5 V_s d + 4.09 \times 10^{-5} Q_h)}{u}$$

where,

H_e = effective stack height, meters

H = stack height, meters

V_s = stack gas ejection velocity, meters per second

u = wind speed, meters per second (Assume 3.8 meters per second unless other acceptable meteorological data are available for the stack locality.)

d = internal diameter of stack top, meters

Q_h = heat emission rate of stack gas relative to ambient atmosphere, calories per second

$$Q_h = Q_m C_{ps} DT$$

where,

Q_m = mass emission rate of stack gas, grams per second

C_{ps} = specific heat of stack gas at constant pressure, calories per gram per $^{\circ}K$.

DT = $T_s - T$

T_s = temperature of stack gas at stack top, $^{\circ}K$

T = temperature of ambient atmosphere, $^{\circ}K$ (Assume ambient atmospheric temperature is 293 $^{\circ}K$.)

The attached graphs have been plotted from Sutton's equation, as modified above, using the following data:

u = 3.8 meters per second mean wind speed

C^2 = 0.010 M^n

n = 0.25

Z = 100 micrograms per cubic meter for Type A Land Use

Z = 125 micrograms per cubic meter for Type B Land Use

Z = 150 micrograms per cubic meter for Type C Land Use
Z = 175 micrograms per cubic meter for Type D Land Use
H_e = 33, 66, 131, 197, 262, 328, 394, 459, 525 and 591 feet
X = 1000 to 70,000 feet

This graph shows the solution only for the region where Q_a increases with X. The region where Q_a decreases with X has been replaced by a vertical line.

The allowable emission rate for particulate matter shall be determined as follows:

1. Determine effective stack height for the source in question and select the proper curve on the graph.
2. Determine the distance from the property line or the affected area to the stack, and locate on the left-hand vertical scale. Read across at this point on the scale to the previously selected curve for effective stack height.
3. Then read down to the corresponding point on the horizontal scale to determine the allowable emission rate for the land use type of the affected area.

C. Multiple Stacks

For a property containing more than one stack, calculations shall be made from the modified Sutton's Equation (Page I-C1) for each stack and the additive effect for the stack emissions on the affected area determined. The owner of a multi-stack property may elect to use a computer program to calculate the additive effect of his multiple stack sources on adjacent properties, provided he provides the Executive Secretary a duplicate of the computer program and obtains the approval of the Executive Secretary of the program.

SUSPENDED PARTICULATE MATTER

