RULE 411, BOILER NO_X
Adopted 02-02-95
(Amended 11/7/96, 01/09/97, 7/22/99)

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100 **GENERAL**

101 **PURPOSE:** To limit NO_X and CO emissions from industrial, institutional, and commercial boilers, steam generators, and process heaters.

102 **APPLICABILITY:** The requirements of this Rule shall apply to boilers, steam generators and process heaters with a rated heat input capacity of 5 million Btu per hour or greater, used in industrial, institutional, and commercial operations.

110 **EXEMPTION - EQUIPMENT RATING:** The requirements of this Rule shall not apply to any unit with a rated heat input capacity of less than 5 million Btu per hour.

111 **EXEMPTION - ELECTRIC UTILITY BOILERS:** The requirements of this Rule shall not apply to any unit that is exclusively used by an electric utility to generate electricity.

112 **EXEMPTION - PROCESS HEATERS, KILNS, AND FURNACES:** The requirements of this Rule shall not apply to process heaters, kilns, and furnaces where the products of combustion come into direct contact with the material to be heated.

113 **EXEMPTION - WASTE HEAT RECOVERY BOILERS:** The requirements of this Rule shall not apply to waste heat recovery boilers used to recover heat from the exhaust of combustion turbines or reciprocating internal combustion engines.

114 **EXEMPTION - LOW FUEL USAGE:** The requirements of Sections 301 through 304 shall not apply to any unit that uses less than 90,000 therms per year of fuel provided that the owner or operator complies with one of the requirements listed in Section 305. If the fuel usage for any unit claiming this exemption exceeds or equals 90,000 therms in any calendar year, then the unit must be operated in compliance with the applicable NOx and CO emission limits in Sections 301 through 304. This exemption applies only to owners or operators that applied for use of this exemption on or before May 31, 1997, and received approval pursuant to Rule 201 – General Permit Requirements.

200 DEFINITIONS

201 **ANNUAL HEAT INPUT:** The total input of fuels burned by a unit in a calendar year, as determined from the higher heating value and cumulative annual usage of each fuel.

202 **BEST AVAILABLE RETROFIT CONTROL TECHNOLOGY (BARCT):** Best available retrofit control technology as defined in Section 40406 of the California Health and Safety Code is "an emission limitation that is based on the maximum degree of reduction achievable, taking into account environmental, energy, and economic impacts by each class or category of sources." These limits are specified in Sections 301, 302, and 303.

203 **BIOMASS:** Any solid, organic material used as a fuel source for boilers or steam generators including, but not limited to, wood, almond shells, or agricultural waste.

204 **BIOMASS BOILER OR STEAM GENERATOR:** Any unit used in any institutional, commercial, or industrial operation that is designed to burn biomass fuel to produce steam, heat water and/or other fluids, and/or generate electricity. For the purpose of this rule, a unit that simultaneously burns multiple fuels including biomass fuel shall be considered a biomass boiler or steam generator.

205 **BOILER OR STEAM GENERATOR:** Any unit fired with any fuel used to produce steam or heat water that is not used exclusively to produce electricity for sale. Boiler or Steam Generator does not include any waste heat recovery boiler that is used to recover sensible heat from the exhaust of a combustion turbine or reciprocating internal combustion engines.

206 **BRITISH THERMAL UNIT (BTU):** The amount of heat required to raise the temperature of one pound of water from 59 ^{o}F to 60 ^{o}F at one atmosphere.

207 **HEAT INPUT:** The chemical heat released due to fuel combustion in a combustion unit, using the higher heating value of the fuel. This does not include the sensible heat of incoming combustion air.

208 **GASEOUS FUEL:** Any fuel which is a gas at standard conditions.

209 **HIGH HEATING VALUE (HHV):** The total heat liberated per mass of fuel burned (Btu per pound), when fuel and dry air at standard conditions undergo complete combustion and all resultant products are brought to their standard states at standard conditions. If certification of the HHV is not provided by the third party fuel supplier, it shall be determined by one of the test methods specified in Section 501.2.

210 **MALFUNCTION:** Any sudden and unavoidable failure of air pollution control equipment or process equipment or of a process to operate in a normal or usual manner. Failures that are caused entirely or in part by poor maintenance, careless operation, or any other preventable upset condition or preventable equipment breakdown shall not be considered malfunction.

211 **NITROGEN OXIDES (NO_X):** The sum of nitric oxide and nitrogen dioxide in the flue gas.

212 **NONGASEOUS FUEL:** Any fuel which is not a gas at standard conditions.

213 **PARTS PER MILLION BY VOLUME (PPMV):** The ratio of the number of gas molecules of a given species, or group, to the number of millions of total gas molecules.

214 **PROCESS HEATER:** Any unit fired with any fuel which transfers heat from combustion gases to water or process streams. Process heater does not include any dryer in which the material being dried is in direct contact with the products of combustion, cement or lime kilns, glass melting furnaces, or smelters.

215 **RATED HEAT INPUT CAPACITY:** The heat input capacity in million Btu per hour specified in the nameplate of the combustion unit. If the heat input capacity on the nameplate of the unit's burner is different than the heat input capacity on the nameplate of the unit's boiler, the heat input capacity of the burner will be used to determine rated heat input capacity. If the burner or boiler has been altered or modified such that its maximum heat input capacity is different than the heat input capacity specified on the name plate, the maximum heat input capacity shall be considered as rated heat input capacity.

216 **RETROFIT:** Any physical change to an emissions unit necessary for reducing NO_x and CO emissions to comply with the NO_x and CO emissions limits specified in Sections 301 through 304 of this rule, including, but not limited to, burner replacement, addition of emissions control equipment, and addition of oxygen trim systems. Changes in the method of operation shall not be considered as retrofit.

217 **SHUTDOWN:** The period of time a unit is cooled from its normal operating temperature. The shutdown period shall be limited to two hours.

218 **STANDARD CONDITIONS:** For the purpose of this rule, standard conditions are 68 ^{o}F and one atmosphere.

219 **STARTUP:** The period of time, not to exceed two hours, in which a unit is brought to its operating temperature and pressure immediately after a period in which the gas flow is shut off for a continuous period of 30 minutes or longer.

220 **THERM:** One hundred thousand (100,000) Btu's.

221 **UNIT:** Any boiler, steam generator, as defined in Section 205, or process heater, as defined in Section 214.

222 **WOOD:** Wood, wood residue, bark, or any derivative fuel or residue thereof, in any form, including but not limited to sawdust, dust from sanding, wood chips, scraps, slabs, millings, shavings, and processed pellets made from wood or other forest residues.

300 STANDARDS

301 BARCT EMISSIONS LIMITS - GASEOUS FUEL FIRING

301.1 **NO_x Emissions**: Except as provided in Section 114, the NO_X emissions from any unit shall not exceed 30 parts per million by volume on a dry basis, as determined pursuant to Section 501, and corrected to three percent oxygen (30 ppmvd @ 3% O_2), when firing on gaseous fuels.

301.2 **CO Emissions:** Except as provided in Section 114, the CO emissions from any unit shall not exceed 400 parts per million by volume on a dry basis, as determined pursuant to Section 501, corrected to 3 percent oxygen (400 ppmvd @ 3% O_2), when firing on gaseous fuels.

302 BARCT EMISSIONS LIMITS - NONGASEOUS FUEL FIRING

302.1 **NO_x Emissions:** Except as provided in Section 114, the NO_X emissions from any unit shall not exceed 40 parts per million by volume on a dry basis, as determined pursuant to Section 501, corrected to three percent oxygen (40 ppmvd @ 3% O_2), when firing on nongaseous fuels.

302.2 **CO Emissions:** Except as provided for in Section 114, the CO emissions from any unit shall not exceed 400 parts per million by volume on a dry basis, as determined pursuant to Section 501, corrected to three percent oxygen (400 ppmvd @ 3% O_2), when firing on nongaseous fuels.

303 BARCT EMISSIONS LIMITS - BIOMASS FUEL FIRING

303.1 **NO_x Emissions:** Except as provided in Section 114, the NO_X emissions from any unit shall not exceed 70 parts per million by volume on a dry basis, as determined pursuant to Section 501, corrected to twelve percent carbon dioxide (70 ppmvd @ 12% CO_2), when firing on biomass fuels.

303.2 **CO Emissions:** Except as provided in Section 114, the CO emissions from any unit shall not exceed 400 parts per million by volume on a dry basis, as determined pursuant to Section 501, corrected to twelve percent carbon dioxide (400 ppmvd @ 12% CO_2), when firing on biomass fuels.

304 EMISSION LIMIT - EMERGENCY STANDBY NONGASEOUS FUEL FIRING

304.1 **NO_x Emissions:** The NO_x emissions from any unit which normally burns gaseous fuel but burns nongaseous fuel only during emergency interruption of gaseous fuel supply by the serving utility shall not exceed 150 parts per million by volume on a dry basis as determined pursuant to Section 501, corrected to three percent oxygen (150 ppmvd @ 3% O_2), when firing on nongaseous fuel. Operation of the unit under this Section shall not exceed 168 hours per calendar year, excluding equipment and emission testing time, not exceeding 48 hours per calendar year.

305 **LOW FUEL USAGE:** Any unit exempted pursuant to Section 114 shall meet one of the following conditions:

305.1 The unit shall be operated in a manner that maintains stack-gas oxygen concentrations at less than or equal to 3.00 % by volume on a dry basis; or

305.2 The unit shall be tuned at least once per year by a qualified technician. If the unit is not operational for the entire calendar year, then no tune-up shall be required until re-startup of the unit. The tune-up shall be performed in accordance with the procedure described in ATTACHMENT A; or

305.3 The unit shall be operated in compliance with the applicable emission levels specified in Sections 301 through 304.

305.4 Sources applying after May 31, 1997 are not eligible to receive this exemption.

306 **EQUIPMENT REQUIREMENT - FUEL CONSUMPTION**

306.1 Owners or operators of units subject to the requirements of Section 304 shall install a non-resetting totalizing hour meter on each unit, or shall install a computerized tracking system that maintains a continuous daily record of hours of operation.

306.2 Owners or operators of units subject to the requirements of Section 305 shall:

a. Install a non-resetting totalizing fuel meter in the fuel line for each fuel burned. Each unit serviced by the fuel line shall have a meter installed to monitor fuel consumption. If a volumetric flow meter is installed, it must compensate for pressure and temperature using integral gauges; or

b. Install a non-resetting totalizing hour meter. This requirement shall apply to each unit. In this case, the fuel usage shall be calculated by multiplying the number of operating hours for the unit by the maximum fuel usage for the unit as specified by the unit manufacturer; or

c. Install a computerized tracking system that maintains a continuous daily record of hours of operation and/or fuel consumption rate for each fuel line. This requirement shall apply to each unit serviced by a fuel line. If only hours of operation are recorded, the fuel usage shall be calculated by multiplying the number of operating hours for the unit by the maximum fuel usage for the unit as specified by the unit manufacturer. If both hours of operation and fuel consumption rate are recorded, the actual recorded fuel consumption rate shall be integrated over the actual number of hours operated to determine total fuel usage.

400 ADMINISTRATIVE REQUIREMENTS

401 **LOW FUEL USAGE:** The owner or operator of any unit claiming exemption pursuant to Section 114 that is required to install new fuel consumption monitoring equipment must comply with Section 306 by January 22, 2000. New fuel consumption equipment is required when one fuel meter, hour meter, or computerized tracking system serves multiple boilers and/or other equipment prior to July 22, 1999.

402 **REPORTING – TUNE-UP VERIFICATION:** The owner or operator of units subject to the requirements of Section 305.2 shall submit to the Air Pollution Control Officer a tune-up verification report or a verification of inactivity not less than once every calendar year for each unit.

403 **SOURCE TESTING FREQUENCY:** The owner or operator of units subject to the emissions limits set forth in Sections 301 through 303 shall conduct source testing using the test methods specified in Section 501 of this rule according to the following schedule:

a. Any unit with a rated heat capacity of 25 million Btu per hour or greater shall be tested within 1 year of July 22, 1999, and once every calendar year thereafter.

b. Any unit with a rated heat capacity greater than or equal to 5 million Btu per hour but less than 25 million Btu per hour shall be tested within 2 years of July 22, 1999 and once every second calendar year thereafter.

c. Any unit that is equipped with a continuous emission monitoring system (CEMs) shall conduct accuracy testing using the methods specified in Section 501 of this rule once every calendar year.

404 **SOURCE TESTING PROTOCOL:** At least 30 days prior to the scheduled source test date, the owner or operator of a unit subject to this rule shall submit a source test plan to the Air Pollution Control Officer. At least seven days prior to the source test, the owner or operator shall notify the Air Pollution Control Officer of the exact date and time of the source test. A final source test report, and the applicable source test observation and evaluation fee as authorized under Rule 301, shall be submitted to the Air Pollution Control Officer within 60 days following the actual source test date.

500 MONITORING AND RECORDS

501 TEST METHODS

501.1 **GASEOUS EMISSIONS: SOURCE TEST**: Compliance with the NO_X emission requirements and the stack gas carbon monoxide and oxygen requirements of Sections 301 through 304 shall be determined using the test methods specified below. All emissions determinations shall be made in the as-found operating condition, except no compliance determination shall be established during unit startup as defined in Section 219, or shutdown as defined in Section 217. Tests shall be conducted while units are operating at a firing rate that is as close as physically possible to the unit's rated heat input capacity. Tests shall be conducted for three 40 minute runs. Results shall be averaged over the three test periods. Test reports shall include the operational characteristics of all flue-gas NO_X reduction equipment.

a. Oxide of Nitrogen - ARB Method 100 or EPA Method 7E.
b. Carbon Monoxide - ARB Method 100 or EPA Method 10.
c. Stack Gas Oxygen - ARB Method 100 or EPA Method 3A.
d. Carbon Dioxide - ARB Method 100 or EPA Method 3A.

501.2 **GASEOUS EMISSIONS: CONTINUOUS EMISSIONS MONITORING SYSTEMS (CEMS):** Compliance with NOx emission requirements specified in Sections 301 through 304 may also be determined using CEMS. All emissions determinations shall be made in the as-found operating condition, except no compliance determination shall be established during unit startup as defined in Section 219, or shutdown as defined in Section 217. Where the unit(s) are equipped with CEMS:

a. **General:** All CEMS must be installed according to the procedures specified in 40CFR160.13g. All CEMS shall be installed such that a representative measurement of emissions is obtained. Additional procedures for the location of CEMS found in 40CFR60 Appendix B shall be used. The data recorder for CEMS shall be in operation at all times.
b. **Cycle time:** The owner or operator of any unit using a continuous emission monitoring system (CEM) shall ensure that the CEM system completes a minimum of one cycle of operation (sampling, analyzing, and data recording) for each successive 15 minute period.
c. **Calibration:** Zero and span shall be checked once every 24 hours.
d. **Averaging:** The data recorded during periods of calibration checks, zero and span adjustments shall not be included in averaging for compliance determinations. Compliance shall be determined on an hourly basis using the average of the 3 previous 1 hour average emissions concentrations. The 1-hour average emissions concentration shall be determined from at least two data points recorded by the CEMs.
e. **Accuracy Testing:** Accuracy testing of Continuous Emission Monitoring Systems shall be conducted using a relative accuracy test audit pursuant to 40CFR60 Appendix F.

501.3 **HIGH HEAT VALUE:** HHV shall be determined by one of the following test methods:

a. ASTM D 2015-85 for solid fuels; or
b. ASTM D 240-87 or ASTM D 2382-88 for liquid hydrocarbon fuels; or
c. ASTM D 1826-88, or ASTM D 1945-81 in conjunction with ASTM D 3588-89 for gaseous fuels.

502 RECORDKEEPING

502.1 The owner or operator of units subject to the requirements of Section 304 shall monitor and record for each unit the cumulative annual hours of operation on each emergency standby non-gaseous fuel.

502.2 The owner or operator of units subject to the requirements of Section 305 shall monitor and record for each unit the HHV and cumulative gaseous and non-gaseous fuel usage.

500.3 The owner or operator of any unit subject to Section 501 of this rule shall maintain copies of all CEMS data and final source test reports.

502.4 Such records shall be maintained on-site for a continuous 5-year period and made available for review by the Air Pollution Control Officer upon request.

ATTACHMENT A

Tuning Procedure[1]

Nothing in this Tuning Procedure shall be construed to require any act or omission that would result in unsafe conditions or would be in violation of any regulation or requirement established by Factory Mutual, Industrial Risk Insurers, National Fire Prevention Association, the California Department of Industrial Relations (Occupational Safety and Health Division), the Federal Occupational Safety and Health Administration, or other relevant regulations and requirements.

1. Operate the unit at the firing rate most typical of normal operation. If the unit experiences significant load variations during normal operation, operate it at its average firing rate.

2. At this firing rate, record stack gas temperature, oxygen concentration, and CO concentration (for gaseous fuels) or smoke-spot number[2] (for liquid fuels), and observe flame conditions after unit operation stabilizes at the firing rate selected. If the excess oxygen in the stack gas is at the lower end of the range of typical minimum values[3] and if the CO emissions are low and there is no smoke, the unit is probably operating at near optimum efficiency - at this particular firing rate. However, complete the remaining portion of this procedure to determine whether still lower oxygen levels are practical.

3. Increase combustion air flow to the furnace until stack gas oxygen levels increase by one to two percent over the level measured in Step 2. As in Step 2, record the stack gas temperature, CO concentration (for gaseous fuels) or smoke-spot number (for liquid fuels), and observe flame conditions for these higher oxygen levels after boiler operation stabilizes.

4. Decrease combustion air flow until the stack gas oxygen concentration is at the level measured in Step 2. From this level gradually reduce the combustion air flow, in small increments. After each increment, record the stack gas temperature, oxygen concentration, CO concentration (for gaseous fuels) and smoke-spot number (for liquid fuels). Also, observe the flame and record any changes in its condition.

5. Continue to reduce combustion air flow stepwise, until one of these limits is reached:

a. Unacceptable flame conditions - such as flame impingement on furnace walls or burner parts, excessive flame carryover, or flame instability.

b. Stack gas CO concentrations greater than 400 ppm.

c. Smoking at the stack.

d. Equipment-related limitations - such as low wind box/furnace pressure differential, built in air-flow limits, etc.

6. Develop an O_2 /CO curve (for gaseous fuels) or 02/smoke curve (for liquid fuels) similar to those shown in Figures 1 and 2 using the excess oxygen and CO or smoke-spot number data obtained at each combustion air flow setting.

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[1]. This tuning procedure is based on a tune-up procedure developed by KVB, Inc. for the EPA.

[2]. The smoke-spot number can be determined with ASTM test method D-2156 or with the Bacharach method.

[3]. Typical minimum oxygen levels for boilers at high firing rates are:

1. For natural gas: 0.5 - 3%
2. For liquid fuels: 2 - 4%

ATTACHMENT A

7. From the curves prepared in Step 6, find the stack gas oxygen levels where the CO emissions or smoke-spot number equal the following values:

Fuel	Measurement	Value
Gaseous	CO Emissions	400 ppm
#1 and #2 oils	smoke-spot number	number 1
#4 Oil	smoke-spot number	number 2
#5 Oil	smoke-spot number	number 3
Other oils	smoke-spot number	number 4

The above conditions are referred to as the CO or smoke thresholds, or as the minimum excess oxygen levels.

Compare this minimum value of excess oxygen to the expected value provided by the combustion unit manufacturer. If the minimum level found is substantially higher than the value provided by the combustion unit manufacturer, burner adjustments can probably be made to improve fuel and air mix, thereby allowing operations with less air.

8. Add 0.5 to 2.0 percent to the minimum excess oxygen level found in Step 7 and reset burner controls to operate automatically at this higher stack gas oxygen level. This margin above the minimum oxygen level accounts for fuel variations, variations in atmospheric conditions, load changes, and nonrepeatability or play in automatic controls.

9. If the load of the combustion unit varies significantly during normal operation, repeat Steps 1-8 for firing rates that represent the upper and lower limits of the range of the load. Because control adjustments at one firing rate may affect conditions at other firing rates, it may not be possible to establish the optimum excess oxygen level at all firing rates. If this is the case, choose the burner control settings that give best performance over the range of firing rates. If one firing rate predominates, setting should optimize conditions at the rate.

10. Verify that the new settings can accommodate the sudden load changes that may occur in daily operation without adverse effects. Do this by increasing and decreasing load rapidly while observing the flame and stack. If any of the conditions in Step 5 result, reset the combustion controls to provide a slightly higher level of excess oxygen at the affected firing rates. Next, verify these new settings in a similar fashion. Then make sure that the final control settings are recorded at steady-state operating conditions for future reference.

ATTACHMENT A

Figure 1

Oxygen/CO Characteristic Curve

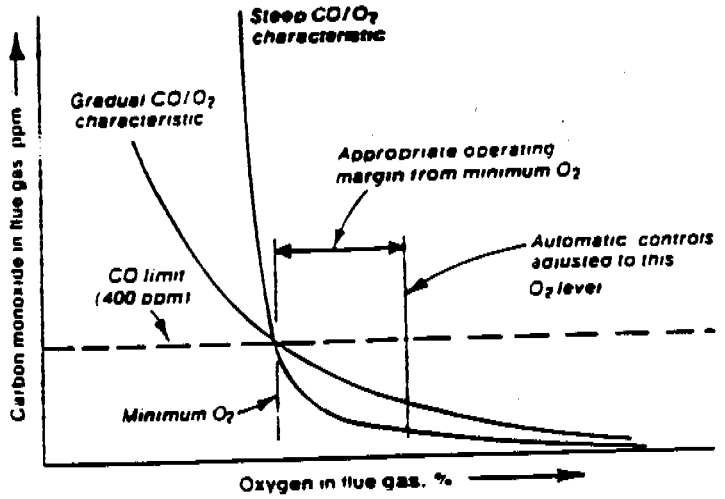
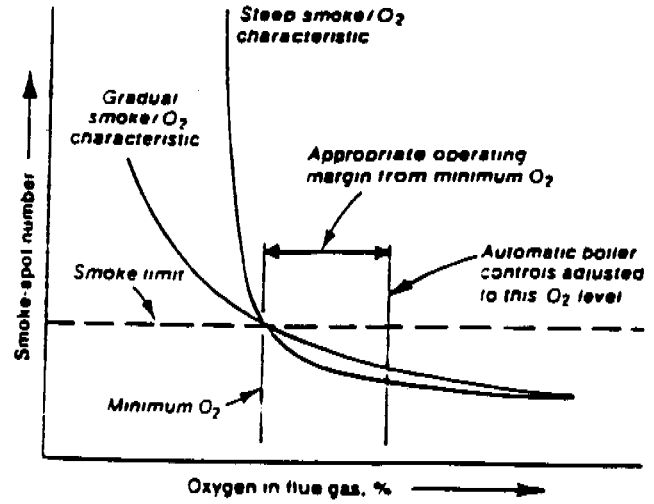


Figure 2

Oxygen/Smoke Characteristic Curve



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