RULE 411, NO_X FROM BOILERS, PROCESS HEATERS AND STEAM GENERATORS
Adopted 02-02-95
(Amended 11/7/96, 01/09/97, 7/22/99, 10/27/05, 8/23/07)

INDEX

100 GENERAL

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

102 **APPLICABILITY:** The requirements of this Rule shall apply to units (i.e., boilers, steam generators and process heaters) fired on gaseous or nongaseous fuels with a rated heat input capacity of 1 million Btu per hour or greater.

110 **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.

111 **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.

112 **EXEMPTION - WASTE HEAT RECOVERY BOILERS:** The requirements of this Rule shall not apply to waste heat recovery boilers.

113 **EXEMPTION - LOW FUEL USAGE:**

113.1 The requirements of Sections 301 and 302 that are effective May 31, 1997, and 303 and 304 shall not apply to any unit rated at 5 million Btu per hour input or greater 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. Additionally, any unit exempt pursuant to this section must comply with the recordkeeping requirements in Section 502.

113.2 a. The requirements of Sections 301 and 302 that are effective pursuant to the applicable schedule in Section 407, shall not apply to any unit with annual usage below the applicable level in the table below

Boiler Size (mmBtu/hr)	Annual Fuel Usage (therms/yr)
1 - <2.5	40,000
≥2.5 - <5	70,000
≥5 - <100	200,000
≥100	300,000

if the owner or operator of the unit complies with all of the following:

1. The operational requirement in Section 305.1 or 305.2;
2. The unit was installed prior to October 27, 2005, or installed after October 27, 2005 and permit application deemed complete prior to October 27, 2005;
3. The monitoring requirement in Section 306.2;
4. The recordkeeping requirements in Section 502; and
5. A complete application for Authority to Construct pursuant to Rule 201-GENERAL PERMIT REQUIREMENTS to establish fuel usage limitations is:
   A. Submitted to the District by October 27, 2006; or
   B. Submitted to the District after October 27, 2006 and includes records that clearly demonstrate that the unit has operated below the low fuel usage limits established above at all times since October 27, 2006.

b. If after October 27, 2006 the annual fuel usage for any unit exempt pursuant

to this section exceeds or equals the level specified in the table in Section 113.2.a., then the unit must comply with the requirements in Section 405.

114 **EXEMPTION – STANDING PILOT FLAME BURNER:** The NOx emission requirements in Section 301 shall not apply to a standing pilot flame burner that is used in a load following unit to sustain low steam demand. To qualify for this exemption, the standing pilot flame burner heat input rating shall not exceed 5 mmBtu/hr. Additionally, the NOx emissions from the standing pilot flame shall not exceed 30 ppmvd @ 3% O2, except for startup and shutdown periods. Any source test required by Section 403 shall include separate testing of the standing pilot flame burner for which this exemption is claimed.

200 DEFINITIONS

201 **ANNUAL FUEL USAGE (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, 303, and 304.

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 BIOMASS STEAM GENERATOR:** A boiler or steam generator that burns a fuel containing biomass.

205 **BOILER OR STEAM GENERATOR:** Any external combustion equipment fired with any fuel used to produce hot water or steam, excluding waste heat recovery boilers.

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 or volume of fuel burned (Btu per pound, cubic foot, or gallon), 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 501.3.

210 **LANDFILL GAS:** Any gas derived through any biological process from the decomposition of waste buried within a waste disposal site.

211 **LOAD FOLLOWING UNIT:** A unit with normal operational load fluctuations and requirements, imposed by fluctuations in the process(es) served by the unit, which exceed the operational response range of an Ultra-Low NOx burner system(s) operating at 9 ppmv NOx. The operator shall designate load-following units on the Permit to Operate.

212 **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.

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

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

215 **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.

216 **PROCESS HEATER:** Any unit fired with any fuel which transfers heat from combustion gases to water or process streams, including reformers as defined in Section 218. 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.

217 **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.

218 **REFORMER**: A furnace in which a hydrocarbon feedstock is reacted with steam over a catalyst at high temperature to form hydrogen and lesser amounts of carbon monoxide and carbon dioxide.

219 **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.

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

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

222 **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.

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

224 **UNIT:** Any boiler, including steam generator, as defined in Section 204 or Section 205, or process heater, as defined in Section 216.

225 **WASTE HEAT RECOVERY BOILER:** A device that recovers normally unused energy and converts it to usable heat. Waste heat recovery boilers incorporating duct or supplemental burners that are designed to supply 50 percent or more of the total rated heat input capacity of the waste heat recovery boiler are not considered waste heat recovery boilers, but are considered boilers. Waste heat recovery boilers are also referred to as heat recovery steam generators.

226 **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:** Except as provided in Section 113, the NO_X and CO emissions from any unit shall not exceed the limits specified in the table below. The NOx and CO emission limits shall be measured as parts per million by volume on a dry basis, as determined pursuant to Section 501, and corrected to three percent oxygen, when firing on gaseous fuels.

Unit Size/Description mmBtu/hr Input	Effective May 31, 1997		Effective (See Section 407)	
	NOx Limit ppmvd@ 3% O2	CO Limit ppmvd@ 3% O2	NOx Limit ppmvd@3 % O2	CO Limit ppmvd@ 3% O2
Greater than or equal to 1 and less than 5	-	-	30	400
Greater than or equal to 5 and less than or equal to 20	30	400	15	400
Greater than 20	30	400	9	400
Gas Fired Reformer Furnaces	30	400	30	400
Greater than or equal to 5 and fired on landfill gas or a combination of landfill gas and natural gas	30	400	15	400
Load Following Units greater than or equal to 5 mmBtu/hr input	30	400	15	400

302 **BARCT EMISSIONS LIMITS - NONGASEOUS FUEL FIRING:** Except as provided in Section 113, the NO_X and CO emissions from any unit shall not exceed the limits specified in the table below. The NOx and CO emission limits shall be measured as parts per million by volume on a dry basis, as determined pursuant to Section 501, and corrected to three percent oxygen, when firing on nongaseous fuels.

Unit Size/Description mmBtu/hr Input	Effective May 31, 1997		Effective (See Section 407)	
	NOx Limit ppmvd@3% O2	CO Limit ppmvd@3 % O2	NOx Limit ppmvd@3% O2	CO Limit ppmvd@3% O2
Greater than or equal to 1 and less than 5	-	-	40	400
Greater than or equal to 5	40	400	40	400

303 **BARCT EMISSIONS LIMITS - BIOMASS FUEL FIRING**

303.1 **NO_x Emissions:** Except as provided in Section 113.1, 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 113.1, 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 113 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.

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 when the boiler is operated on nongaseous fuel.

306.2 Owners or operators of units exempt from the NOx and CO requirements in Sections 301 through 303 pursuant to Section 113 because of low fuel usage 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:**

401.1 The owner or operator of any unit claiming exemption pursuant to Section 113.1 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.

401.2 The owner or operator of any unit claiming exemption pursuant to Section 113.2 that is required to install new fuel consumption monitoring equipment must comply with Section 306 by October 27, 2007.

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 perform emissions source testing using the test methods specified in Section 501 of this rule according to the following schedule and maintain records as provided in Section 502:

403.1 Except as provided in Section 405.2, an initial source test to verify compliance with

the NOx and CO emission limits effective **[See Section 407 for specific compliance dates]** listed in Sections 301 and 302 shall be conducted by the full compliance date specified in Section 407;

403.2. Any unit with a rated heat capacity of 20 million Btu per hour or greater shall be tested once every calendar year.

403.3. Any unit with a rated heat capacity greater than or equal to 5 million Btu per hour but less than 20 million Btu per hour shall be tested once every second calendar year.

403.4 **Small Units:** Any unit with a rated heat capacity greater than or equal to 1 million Btu per hour input and less than 5 million Btu per hour input shall be required to be tested to verify compliance with the NOx and CO emission limits pursuant to Section 403.1. As an alternative to testing, the owner or operator of a unit subject to the requirements of this section may use a portable analyzer as part of an Air Pollution Control Officer approved alternate emissions monitoring system. The portable analyzer shall meet the specification standards in Attachment B.

a. At least thirty days prior to the portable analyzer test, the owner or operator shall notify the Air Pollution Control Officer of the exact date and time of the test.

403.5 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:**

404.1 **Source Tests:** 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.

404.2 **Portable Analyzer:** Emission readings using a portable analyzer pursuant to Section 403.4 shall be averaged over a 15 consecutive-minute period by either taking a cumulative 15-consecutive-minute sample reading or by taking at least five (5) readings evenly spaced over the 15-consecutive-minute period. If the results of the portable analyzer show that the NOx emissions from the unit exceed the allowable limits in Section 300, then the unit will be required to be source tested no later than 60 days from the date of discovering such exceedance.

405 **LOSS OF EXEMPTION**: If any unit with a Permit to Operate issued pursuant to Rule 201-GENERAL PERMIT REQUIREMENTS approving an exemption from the requirements in Sections 301 or 302 pursuant to Section 113.2 exceeds or equals the levels specified in the table in Section 113.2 in any calendar year after October 27, 2006**,** the owner or operator shall:

405.1 Maintain compliance with the requirements of Section 305 until compliance is demonstrated with Section 301 or 302; and

405.2 Within 12 months after the end of the calendar year during which the unit exceeded or equaled the fuel usage exemption level, conduct an initial source test and demonstrate compliance with Section 301 or 302. The unit will subsequently not qualify for exemption pursuant to Section 113.2.

406 **ADMINISTRATIVE REQUIREMENTS FOR LOAD FOLLOWING UNITS:** The owner or operator of a load following unit shall submit to the Air Pollution Control Officer with their authority to construct application the following information to demonstrate that the unit(s) qualify as load-following:

406.1. Technical data such as steam demand charts or other information to demonstrate the normal operational load fluctuations and requirements of the unit;

406.2. Technical data showing the operational response range of all reasonably available Ultra-Low NOx burner system(s) operating at 9 ppmv NOx; and

406.3. Technical data demonstrating that the unit(s) are designed and operated to optimize the use of base-loaded units in conjunction with the load-following unit(s).

407 **COMPLIANCE SCHEDULE:** An owner or operator of any unit subject to Section 301 or 302 on or after October 27, 2005 shall comply with this Rule in accordance with the following schedules.

407.1 Except as provided in Section 407.2 and 407.3, for units installed prior to October 27, 2005 and permit application deemed complete by the Air Pollution Control Officer prior to October 27, 2005, or installed after October 27, 2005 and permit application deemed complete prior to October 27, 2005:

Number of Units subject to Sections 301 through 304	Number of these units required to be in full compliance by October 27, 2007	Number of these units required to be in full compliance by October 27, 2008	Number of these units required to be in full compliance by October 27, 2009
1 or 2	1	2	N/A
3	1	2	3
4	2	3	4
5 or 6	2	4	6
More than 6	25% of these units	75% of these units	100% of these units

Note: Full Compliance identifies the date by which the owner shall demonstrate that each unit is in compliance with this rule.

407.2 For units installed after October 27, 2005 and permit application deemed complete by the Air Pollution Control Officer after October 27, 2005: date of installation.

407.3 For units installed prior to October 27, 2005 and permit application deemed complete by the Air Pollution Control Officer after October 27, 2005: October 27, 2006.

500 MONITORING AND RECORDS

501 **TEST METHODS**

501.1 **GASEOUS EMISSIONS: SOURCE TEST**:

a. Compliance with the NO_X and CO emission requirements and the stack gas 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 222, or shutdown as defined in Section 220. 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.

1. Oxide of Nitrogen - ARB Method 100 or EPA Method 7E.
2. Carbon Monoxide - ARB Method 100 or EPA Method 10.
3. Stack Gas Oxygen - ARB Method 100 or EPA Method 3A.
4. Carbon Dioxide - ARB Method 100 or EPA Method 3A.

b. A scheduled source test may not be discontinued solely due to the failure of one or more runs to meet applicable standards.

c. In the event that a sample is accidentally lost or conditions occur in which one of the three runs must be discontinued because of one of the following reasons, then compliance may be determined using the average of the other two runs:

1. Forced shutdown; or
2. Failure of an irreplaceable portion of the sampling train; or
3. Extreme meteorological conditions presenting a hazard to the sampling team; or
4. Other circumstances beyond the owner or operators control as determined by the Air Pollution Control Officer.

d. A source test not conducted pursuant to the source test methods listed in Section 501.1(a) may be rejected and the test report determined to be invalid.

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 222, or shutdown as defined in Section 220. Where the unit(s) are equipped with CEMS:

a. **General:** All CEMS must be installed according to the procedures specified in 40CFR60.13g. 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 the unit is operated.

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. The CEMS shall be calibrated in accordance with the manufacturer's specifications.

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 240-02 or ASTM D 3282-88 for liquid hydrocarbon fuels; or

c. ASTM D 1826-94, or ASTM D 1945-96 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 and 306.1 shall monitor and record for each unit the cumulative calendar year hours of operation on each emergency standby non-gaseous fuel.

502.2 The owner or operator of units exempt pursuant to Section 113 and subject to the requirements of Sections 305 and 306.2a or 306.2c for fuel consumption shall record for each unit the HHV and the calendar year gaseous and non-gaseous fuel usage.

502.3 The owner or operator of units exempt pursuant to Section 113 and subject to the requirements of Sections 305 and 306.2b or 306.2c for hours of operation shall record for each unit the HHV, calendar year hours of operation, and the calendar year calculated fuel usage.

502.4 An owner or operator subject to the requirements in Section 403.4 using a portable analyzer to verify compliance with the NOx and CO emission limits shall keep records of the measured NOx and CO emissions, and all data as specified in Attachment B.

502.5 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 as applicable.

502.6 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]

A. Equipment Tuning Procedure for Forced-Draft Boilers, Steam Generators, and Process Heaters

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-low limits, etc.

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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%

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.

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.

Figure 1
Oxygen/CO Characteristic Curve

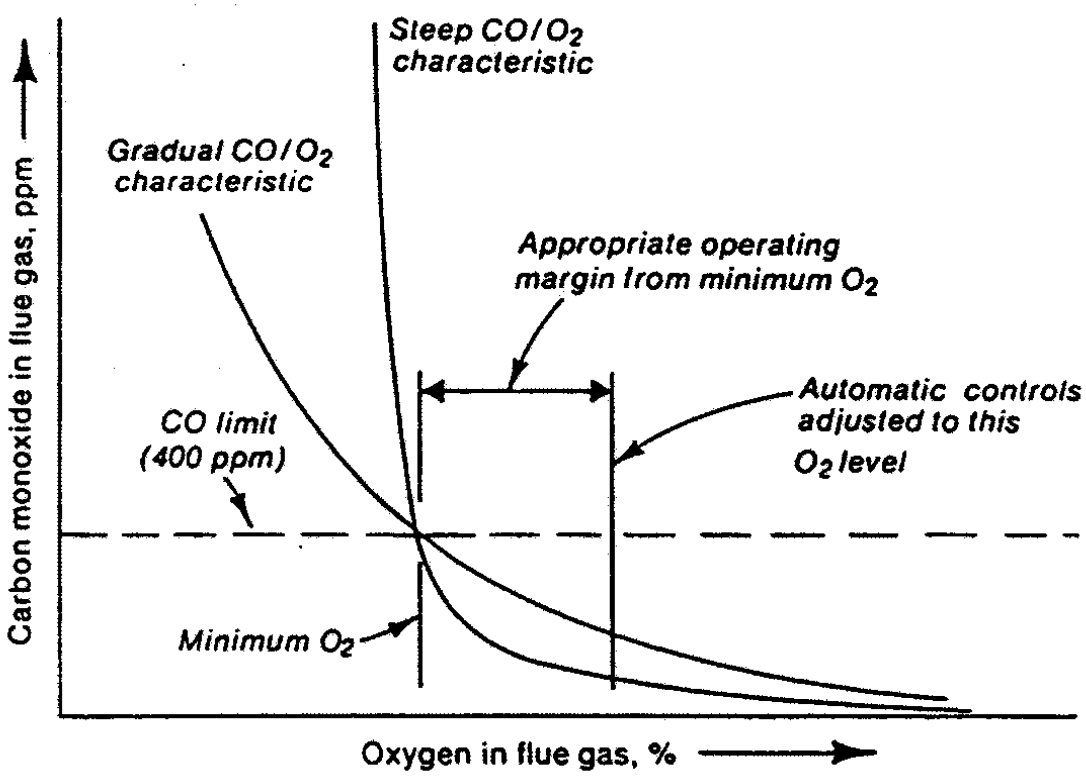
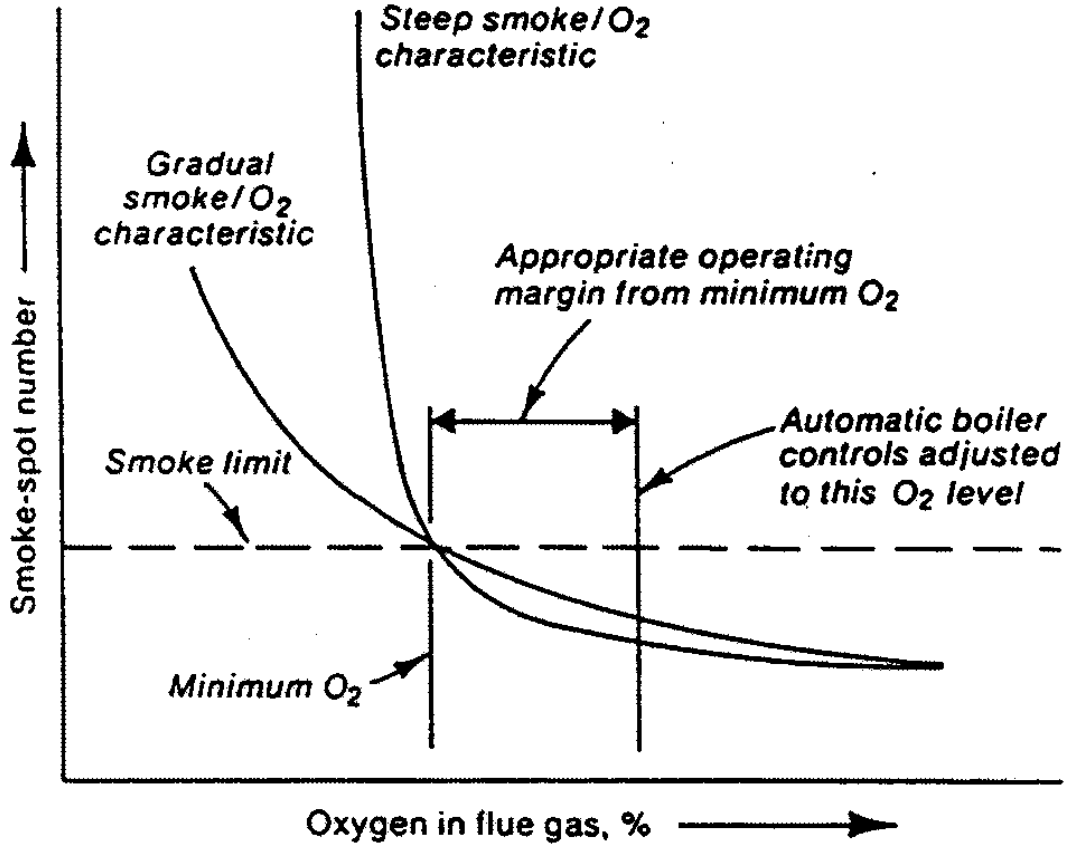


Figure 2
Oxygen/Smoke Characteristic Curve



B. Equipment Tuning Procedure for Natural Draft-Fired Boilers, Steam Generators, and Process Heaters.

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. **PRELIMINARY ANALYSIS**

a. CHECK THE OPERATING PRESSURE OR TEMPERATURE.

Operate the boiler, steam generator, or heater at the lowest acceptable pressure or temperature that will satisfy the load demand. This will minimize heat and radiation losses. Determine the pressure or temperature that will be used as a basis for comparative combustion analysis before and after tuneup.

b. CHECK OPERATING HOURS.

Plan the workload so that the boiler, steam generator, or process heater operates only the minimum hours and days necessary to perform the work required. Fewer operating hours will reduce fuel use and emissions.

c. CHECK AIR SUPPLY.

Sufficient fresh air supply is essential to ensure optimum combustion and the area of air supply openings must be in compliance with applicable codes and regulations. Air openings must be kept wide open when the burner is firing and clear from restriction to flow.

d. CHECK VENT.

Proper venting is essential to assure efficient combustion. Insufficient draft or overdraft promotes hazards and inefficient burning. Check to be sure that vent is in good condition, sized properly and with no obstructions.

e. COMBUSTION ANALYSIS.

Perform an "as is" combustion analysis (CO, O_2, etc.) with a warmed up unit at high and low fire, if possible. In addition to data obtained from combustion analysis, also record the following:

ii. Inlet fuel pressure at burner (at high & low fire)

ii. Draft above draft hood or barometric damper

1) Draft hood: high, medium, and low

2) Barometric Damper: high, medium, and low

iii. Steam pressure, water temperature, or process fluid pressure or temperature entering and leaving the boiler, steam generator, or process heater.

iv. Unit rate if meter is available.

With above conditions recorded, make the following checks and corrective actions as necessary:

1. **CHECKS & CORRECTIONS**

a. CHECK BURNER CONDITION.

Dirty burners or burner orifices will cause boiler, steam generator, or process heater output rate and thermal efficiency to decrease. Clean burners and burner orifices thoroughly. Also, ensure that fuel filters and moisture traps are in place, clean, and operating properly, to prevent plugging of gas orifices. Confirm proper location and orientation of burner diffuser spuds, gas canes, etc. Look for any burned-off or missing burner parts, and replace as needed.

b. CHECK FOR CLEAN BOILER, STEAM GENERATOR, OR PROCESS HEATER TUBES & HEAT TRANSFER SURFACES.

External and internal build-up of sediment and scale on the heating surfaces creates an insulating effect that quickly reduces unit efficiency. Excessive fuel cost will result if the unit is not kept clean. Clean tube surfaces, remove scale and soot, assure proper process fluid flow and flue gas flow.

c. CHECK WATER TREATMENT & BLOWDOWN PROGRAM.

Soft water and the proper water or process fluid treatment must be uniformly used to minimize scale and corrosion. Timely flushing and periodic blowdown must be employed to eliminate sediment and scale build-up on a boiler, steam generator or process heater.

d. CHECK FOR STEAM, HOT WATER OR PROCESS FLUID LEAKS

Repair all leaks immediately since even small high-pressure leaks quickly lead to considerable fuel, water and steam losses. Be sure there are no leaks through the blow-off, drains, safety valve, by-pass lines or at the feed pump, if used.

2. **SAFETY CHECKS**

a. Test primary and secondary low water level controls.

b. Check operating and limit pressure and temperature controls.

c. Check pilot safety shut off operation.

d. Check safety valve pressure and capacity to meet boiler, steam generator or process heater requirements.

e. Check limit safety control and spill switch.

3. **ADJUSTMENTS**

While taking combustion readings with a warmed up boiler, steam generator, or process heater at high fire perform checks and adjustments as follows:

a. Adjust unit to fire at rate; record fuel manifold pressure.

b. Adjust draft and/or fuel pressure to obtain acceptable, clean combustion at both high, medium and low fire. Carbon Monoxide (CO) value should always be below 400 parts per million (PPM) at 3% 0_2. If CO is high make necessary adjustments.

Check to ensure boiler, steam generator, or process heater light offs are smooth and safe. A reduced fuel pressure test at both high and low fire should be conducted in accordance with the manufacturers instructions and maintenance manuals.

c. Check and adjust operation of modulation controller. Ensure proper, efficient and clean combustion through range of firing rates.

When above adjustments and corrections have been made, record all data.

4. **FINAL TEST**

Perform a final combustion analysis with a warmed up boiler, steam generator, or process heater at high, medium and low fire, whenever possible. In addition to data from combustion analysis, also check and record:

a. Fuel pressure at burner (High, Medium, and Low).

b. Draft above draft hood or barometric damper (High, Medium and Low).

c. Steam pressure or water temperature entering and leaving boiler, steam generator, or process heater.

d. Unit rate if meter is available.

When the above checks and adjustments have been made, record data and attach combustion analysis data to boiler, steam generator, or process heater records indicating name and signature of person, title, company name, company address and date the tune-up was performed.

Attachment B

Approvable Portable Analyzer

A. **General:** A portable analyzer consists of a sample interface, a gas detector, and a data recorder, and is used to quantitatively analyze stack gas for one or more components. A portable analyzer for CO, O2, or NOx shall be considered approved by the District if it adheres to the standards that are set forth in this section, is used in accordance with the standards of this section, and is used in accordance with the manufacturer's specifications. Other portable analyzers and techniques are approvable on a case by case basis.

B. **Definitions:**

Sample interface: That portion of the portable analyzer used for one or more of the following: sample acquisition, sample transport, sample conditioning, or protection of the portable analyzer from the effects of the stack effluent.
Gas detector: That portion of the portable analyzer that senses the gas to be measured and generates an output proportional to the gas concentration.
Data recorder: A strip chart recorder, digital recorder, or any other device used for recording or displaying measurement data from the gas detector output.
Resolution: The smallest increment of output that the gas detector will provide. This value should be reported by the equipment manufacturer.
Error: The maximum standard measurement error over the measurement range. This value should be reported by the equipment manufacturer.
Detection Limit: The lowest concentration of gas that can be detected by the gas detector. This value should be reported by the equipment manufacturer.
Response Time: The amount of time required for the portable analyzer to display 95% of a step change in gas concentration on the data recorder.

C. **Equipment:** The portable analyzer shall adhere to the standards tabulated below for each of the pollutants that it is intended to measure. All values in the table refer to maximum values. In addition to the parameters contained in the table, the minimum upper limit of the measurement range shall be equal to 1.5 times the emission limit for the species being measured.

Detector	Resolution	Error	Detection Limit	Response Time
CO	20 ppm	± 50 ppm	50 ppm	1 min
O2	0.5%	± 1.0%	0%	1 min
NOx	2 ppm	± 5 ppm	5 ppm	1 min

D. **Calibration:** Each gas detector shall be calibrated a minimum of once every six months and all instrument calibration data shall be kept on file with the monthly analyses. If the manufacturer recommends calibration more than once every six months, then the instrument calibration shall follow the manufacturer's recommended interval. Two calibration gases are required, the upper limit calibration gas shall have a concentration of 60-100% of the upper limit of the measurement range and the lower limit calibration gas shall have a concentration from 0-10% of the upper limit of the measurement range. Ambient air may be used as the upper limit calibration gas for O2 and may be used as the lower limit calibration gas for both NOx and CO. The system response time shall be determined during the gas detector calibration. The portable analyzer shall first be purged with ambient air. Calibration gas is then provided to the portable analyzer through a tubing length typically used during analysis. The time necessary for the data recorder to display a concentration equal to 95% of the final steady state concentration shall be recorded as the response time.

E. **Measurement:**

1. Concentration measurements shall not be taken until the sample acquisition probe has been exposed to the stack gas for at least 150% of the response time. Measurements shall be taken in triplicate.
2. If water vapor is not removed prior to measurement, the absolute humidity in the gas stream must be determined so that the gas concentrations may be reported on a dry basis. If water vapor creates an interference with the measurement of any component, then the water vapor must be removed from the gas stream prior to concentration measurements.
3. The concentration of NOx is calculated as the sum of the volumetric concentrations of both NO and NO2. The portable analyzer used to detect NOx must either convert NO2 to NO and measure NO, convert NO to NO2 and measure NO2, or measure both NO and NO2. An NO2 to NO converter is not necessary if data are presented to demonstrate that the NO2 portion of the exhaust gas is less than 5 percent of the total NOx concentration.

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