YOLO-SOLANO AIR QUALITY MANAGEMENT DISTRICT

RULE 2.27 - INDUSTRIAL, INSTITUTIONAL, AND COMMERCIAL BOILERS, STEAM GENERATORS, AND PROCESS HEATERS
(Adopted October 27, 1993, Revised August 14, 1996)

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100 GENERAL

101 **PURPOSE:** To provide a control measure to limit emissions of NO_x from industrial, institutional, and commercial boilers, steam generators and process heaters in conformance with BARCT determinations approved by the California Air Resources Board to meet the requirements of the California Clean Air Act.

102 **APPLICABILITY:** This rule applies to boilers, steam generators, and process heaters with rated heat inputs of greater than or equal to 5 million BTU per hour, used in all industrial, institutional, and commercial operations.

110 **EXEMPTION, NONGASEOUS FUELS:** If gas is unavailable for purchase, units which normally burn only gas and are subject to the requirements of Section 301 of this rule shall comply with a NO_x emission limit not to exceed 0.6 lbs/mmbtu when burning nongaseous fuel according to the following equation:

$$(X)*(Y) < 36.12,$$

where:

X = lbs/mmbtu NO_x emission rate, and

Y = hours of operation per calendar year.

36.12 = Regulatory constant

The hours of operation limit in this exemption shall not include equipment testing and emissions testing time of less than 48 hours per calendar year.

111 **EXEMPTION, ELECTRIC UTILITY BOILERS:** The provisions of this rule do not apply to boilers used by electric utilities to generate electricity.

112 **EXEMPTION, WASTE HEAT RECOVERY BOILERS:** The provisions of this rule do not apply to waste heat recovery boilers that are used to recover sensible heat from the exhaust of combustion turbines.

113 **EXEMPTION, DRYERS:** The provisions of this rule do not apply to units in which a material is being dried while in direct contact with the products of combustion.

114 **EXEMPTION, CEMENT AND LIME KILNS, GLASS MELTING FURNACES, AND SMELTERS:** The provisions of this rule do not apply to cement and lime kilns, glass melting furnaces and smelters.

115 **EXEMPTION, LOW-USE PROCESS HEATERS:** Section 300 of this rule does not apply to process heaters used less than 250 hours per calendar year.

200 DEFINITIONS

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

202 **BARCT:** "Best Available Retrofit Control Technology" as defined in section 40406 of the California Health and Safety Code as "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 source".

203 **BOILER OR STEAM GENERATOR:** Any combustion equipment fired with any fuel and used to produce steam that is not used exclusively to produce electricity for sale. This definition does not include any waste heat recovery boiler that is used to recover sensible heat from the exhaust of a combustion turbine.

204 **BRITISH THERMAL UNIT (BTU):** The amount of heat required to raise the temperature of one pound of water from 59°F to 60°F at one atmosphere.

205 **FLUE-GAS NO_x REDUCING TECHNOLOGY**: Engineering controls of NO_x emissions employed after combustion but prior to release from the exhaust stack.

206 **GAS:** Any fuel which is a gas at standard conditions.

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

208 **HIGHER 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. HHV shall be determined by one of the following test methods:

208.1 ASTM D 2015-85 for solid fuels; or

208.2 ASTM D 240-87 or ASTM D 2382-88 for liquid hydrocarbon fuels; or

208.3 ASTM D 1826-88 or ASTM D 1945-81 in conjunction with ASTM D 3588-89 for gaseous fuels.

209 **NO_x EMISSIONS (NO_x):** The sum of nitric oxides and nitrogen dioxide in the flue gas.

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

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

212 **PROCESS HEATER:** Any combustion equipment fired with any fuel, and which transfers heat from combustion gases to water or process streams. This definition does not include any dryers in which the material being dried is in direct contact with the products of combustion, cement or lime kilns, glass melting furnaces, and smelters.

213 **RATED HEAT INPUT:** The heat input capacity, in million BTU per hour, specified on the nameplate of the combustion unit. If the combustion unit has been altered or modified such that its maximum heat input is

different than the heat input capacity specified on the nameplate, the maximum heat input shall be considered as the rated heat input.

214 **SHUT-DOWN:** The period of time a unit is cooled from its operating temperature to ambient temperature, or the time specified by the unit manufacturer.

215 **STANDARD CONDITIONS:** 68°F and one atmosphere.

216 **START-UP:** The period of time a unit is heated from ambient temperature to its operating temperature, or the time specified by the unit manufacturer.

217 **THERM:** One hundred thousand (100,000) BTU.

218 **THREE PREVIOUS CALENDAR YEARS:** The three consecutive years immediately preceding the year in which final compliance is required by this rule, or the three consecutive years immediately preceding each calendar year of compliance thereafter.

219 **UNIT:** Any boiler, steam generator or process heater as defined in Sections 203 and 212 of this rule.

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300 STANDARDS

301**ANNUAL HEAT INPUTS 90,000 THERMS:** For units with rated heat inputs of greater than or equal to 5 million BTU per hour and annual heat inputs of greater than or equal to 90,000 therms for any single calendar year of the three previous calendar years, NO_x emissions shall not exceed the following levels:

301.1 30 parts per million by volume (ppmv), or 0.036 pound per million BTU of heat input when operated on gas; or

301.2 40 parts per million by volume (ppmv), or 0.052 pound per million BTU of heat input, when operated on nongaseous fuel; or

301.3 the heat-input weighted average of the limits specified in 301.1 and 301.2, above, when operated on combinations of gas and nongaseous fuels.

Emissions from units subject to this Section shall not exceed a carbon monoxide concentration of 400 parts per million by volume (ppmv).

302 **ANNUAL HEAT INPUTS < 90,000 THERMS:** Units with rated heat inputs of greater than or equal to 5 million BTU per hour and annual heat inputs of less than 90,000 therms for each of the three previous calendar years or units with rated heat inputs of greater than or equal to 5 million BTU per hour and not subject to the provisions of Section 301 shall:

302.1 Be operated in a manner that maintains stack-gas oxygen concentrations at less than or equal to 3.00 percent by volume on a dry basis during normal, steady state operation (or maintain oxygen concentrations at the optimum O_2 level as specified by the manufacturer); or

302.2 Be tuned not less than once every twelve months by a technician that is qualified to perform a

tune-up in accordance with Section 600 of this rule; or

302.3 Be operated in compliance with the applicable emission levels specified in Section 301 of this rule.

303 **EQUIPMENT REQUIREMENTS**

303.1 Owners or operators of units which simultaneously fire combinations of gaseous and nongaseous fuels, and are subject to the requirements of Section 301 (annual heat inputs greater than or equal to 90,000 therms), shall install mass flow rate meters in each fuel line. Alternatively, volumetric flow rate meters may be installed in conjunction with temperature and pressure meters in each fuel line. All volumetric and mass flow meters required by this section must be non-resettable, totalizing meters.

303.2 Owners or operators of units which employ flue-gas NO_x reducing technology and are subject to the requirements of Section 301 of this rule, shall, through yearly testing or by installing data collection devices, collect sufficient data consistent with determining compliance with this rule. Such measurements may include, but are not limited to, the oxygen concentration, CO concentration, stack-gas temperatures, and/or any other data necessary to accurately assess the effectiveness of the NO_x reduction equipment.

400 ADMINISTRATIVE REQUIREMENTS

401 **COMPLIANCE SCHEDULE:** The owner or operator of units subject to this rule shall fulfill the following increments of progress:

401.1 Submit, by October 27, 1995, a plan containing the following:

a. A list of all units with their rated heat inputs and anticipated annual heat inputs.
b. For owners or operators of units subject to Section 301 (annual heat inputs greater than or equal to 90,000 therms), for each unit listed, the selected method of achieving the applicable standard or standards of Section 301.
c. For owners or operators of units subject to Section 302, for each unit listed, a selection of one of the options specified in Section 302 to achieve compliance with this rule.

401.2 By October 27, 1995, all owners or operators subject to the provisions of this rule shall submit an application for Authority to Construct for any modifications required to achieve compliance with the requirements of this rule.

401.3 By June 1, 1998, all owners or operators subject to this rule shall demonstrate final compliance with all applicable standards and requirements of this rule.

402 **COMPLIANCE DETERMINATION:**

402.1 An owner or operator of any unit(s) shall have the option of complying with either the pounds-per-million-BTU emission rates or the parts-per-million-by-volume emission limits specified in Section 301.

402.2 All emission determinations shall be made in the as-found operating condition, except that emission determinations shall include at a minimum at least one source test conducted at the maximum firing rate allowed by the District permit, and no compliance determination shall be established within two hours after a continuous period in which fuel flow to the unit is zero, or shut off, for thirty minutes or longer.

402.3 All ppmv emission limits specified in Sections 110 and 301 are referenced at dry stack-gas conditions and 3.00 percent by volume stack-gas oxygen. Emission concentrations shall be corrected to 3.00 percent oxygen as follows:

$$[\text{ppm } NO_x]_{corrected} = \frac{20.95\% - 3.00\%}{20.95\% - [\%\ O_2]_{measured}} * [\text{ppm } NO_x]_{measured}$$

$$[\text{ppm } CO]_{corrected} = \frac{20.95\% - 3.00\%}{20.95\% - [\%\ O_2]_{measured}} * [\text{ppm } CO]_{measured}$$

402.4 All pounds-per-million-BTU emission rates shall be calculated as pounds of nitrogen dioxide (N_2) per million BTU of heat input.

402.5 All emission concentrations and emission rates shall be based on 15-consecutive-minute averages. These averages shall be calculated from no less than five data sets, recorded from sampling on intervals of no greater than three minutes.

402.6 All operators of units covered under Sections 301 and 302 shall conduct source tests to demonstrate initial compliance with the requirements of this rule. For units subject to Section 301, operating parameters shall be established during the initial source tests in order to allow future compliance monitoring from tune-up data. Such parameters may include, but are not limited to, the gas flow rate, steam flow rate, steam pressure, excess oxygen levels, CO levels, stack-gas temperatures, or any other parameters that the Air Pollution Control Officer deems necessary to ensure compliance. These operational parameters must be submitted to the District with the initial source test report. Additional source testing may be required by the Air Pollution Control Officer as necessary to ensure compliance with the standards set forth in Sections 301 and 302 of this Rule.

402.7 Sources subject to Section 301 shall perform annual source tests in accordance with Section 502 or tune-ups in accordance with Section 600 to demonstrate compliance with this rule. If annual tune-ups are used to certify compliance, then the tune-up data demonstrating the equipment is operating within the parameters established during the initial source test must be submitted to the District. The Air Pollution Control Officer shall require additional source testing if the tune-up data indicates a deviation from the parameters established in the initial source test.

402.8 Failure to comply with all of the provisions of an approved plan under Section 401.1 shall

constitute a violation of this rule.

402.9 The cumulative annual usage of each fuel shall be monitored from utility service meters, purchase, or tank fill records, or by any other acceptable methods approved by the Air Pollution Control Officer.

403 **TEST REPORTS:** The owners or operators of units subject to Section 301 of this rule shall, at least every twelve months, submit either source or tune-up test reports on each unit for each fuel burned, including any fuels which may be burned in accordance with Section 110. For units complying with Section 302.2, tune-up verification reports shall also be submitted not less than once every twelve months. Test reports shall include the operational characteristics of all flue-gas NO_x reduction equipment that were monitored as required by Section 303.2. The first test or tune-up report, for each unit subject to Section 300 of this rule shall be submitted by June 1, 1998.

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500 MONITORING AND RECORDS

501 **FUEL USAGE AND OPERATING HOURS:** The owners or operators of units subject to Section 300 of this rule shall monitor and record for each unit the HHV and cumulative annual usage of each fuel and the cumulative annual hours of operation during shut-down and start-up procedures as defined in Sections 214 and 216. The owners and operators of units exempt from Section 301 in accordance with Section 110 shall monitor and record for each unit the cumulative hours of operation on each nongaseous fuel. Owners and operators of units exempt from Section 300 in accordance with Section 115 shall monitor and record for each unit the cumulative hours of operation per year. The records shall be updated weekly and made available to the District upon request. Historical annual data for the five previous calendar years shall be kept and made available to the District upon request.

502 **TEST METHODS:**

502.1 Compliance with N_x emission requirements and the stack-gas carbon monoxide and oxygen requirements of Section 300 shall be determined using the following test methods:

a. Oxides of Nitrogen - ARB Method 100.
b. Carbon Monoxide - ARB Method 100.
c. Stack-Gas Oxygen - ARB Method 100.
d. NO_x Emission Rate (Heat Input Basis) - EPA Method 19.

502.2 Test methods other than those specified in Section 502.1 for oxides of nitrogen, stack-gas oxygen, and stack-gas carbon monoxide, may be used to determine compliance so long as they are functionally equivalent and approved by the Air Pollution Control Officer, the California Air Resources Board, and the U.S. EPA.

600 TUNING PROCEDURE

601**GENERAL:** Nothing in these tuning procedures[(1)] 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.

602 **PROCEDURES FOR TUNING MECHANICAL DRAFT BOILERS, STEAM GENERATORS, AND PROCESS HEATERS**:

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

602.2 At the firing rate established in Section 602.1, record stack-gas temperatures, 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 selected firing rate. If the excess oxygen in the stack-gas is at the lower end of the range of typical minimum values[(3)], and if 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.

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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. This Bacharach method is included in a tune-up kit that can be purchased from the Bacharach company.

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

A. For natural gas: 0.5 - 3%
B. For liquid guels: 2 - 4%

602.3 Increase combustion air flow until the stack-gas oxygen levels increase by one or two percent over the level measured in Section 602.2. As in Section 602.2, 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 unit operation stabilizes.

602.4 Decrease combustion air flow until the stack-gas oxygen is at the level measured in Section 602.2. 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.

602.5 Continue to reduce combustion air flow stepwise, until one of the following 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 stack;
d. quipment-related limitations - such as low windbox/furnace pressure differential, built-in air-

flow limits, etc.

602.6 Develop an O_2/CO curve (for gaseous fuels) or O_2/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.

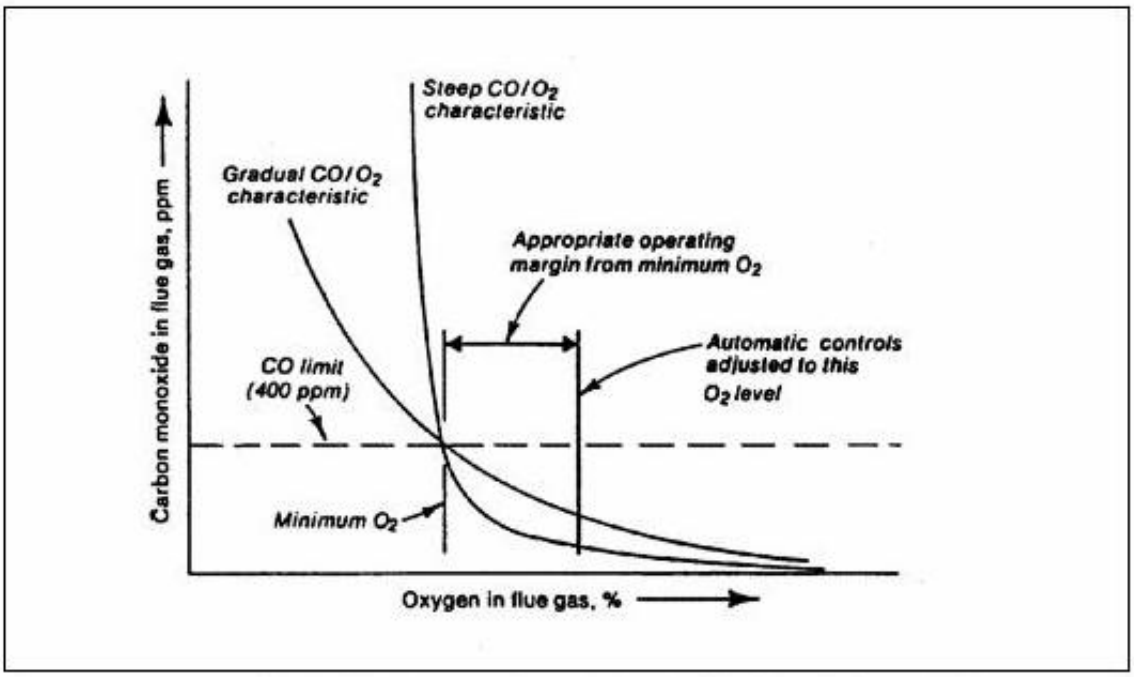

Figure 1 Oxygen/CO Characteristic Curve
(Source: KVB Inc.)

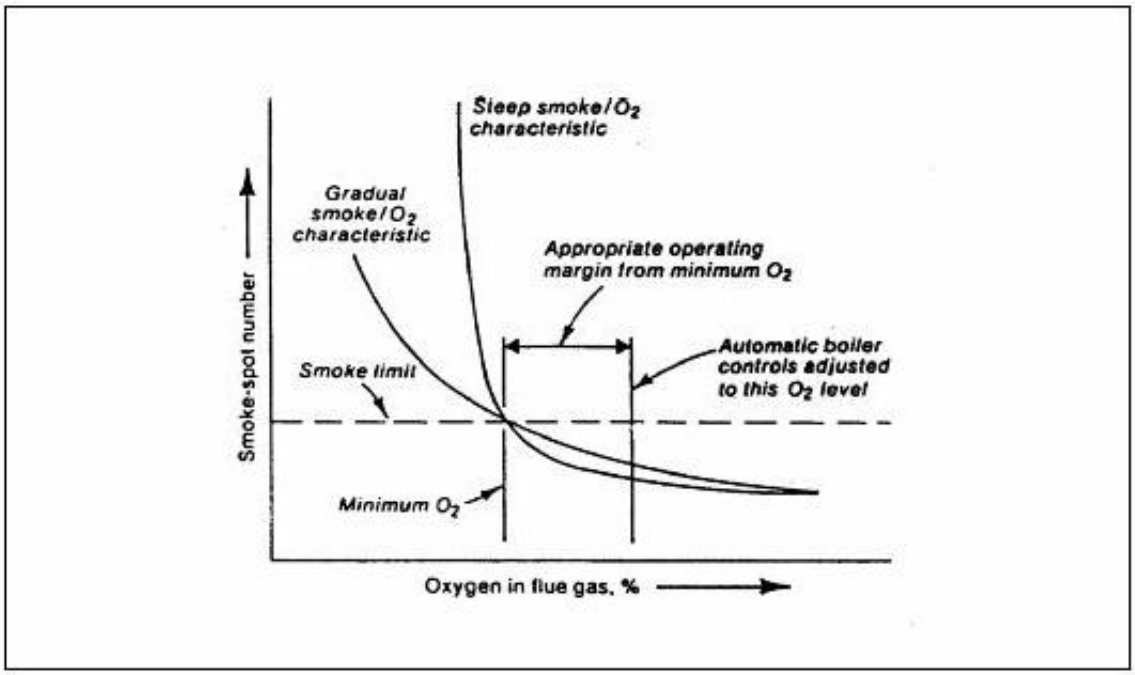

Figure 2 Oxygen/Smoke Characteristic Curve
(Source: KVB Inc.)

602.7 From the curves prepared in Section 602.6, 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 & #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-spot 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 manufacturer, burner adjustments can probably be made to improve fuel and air mix, thereby allowing operations with less air.

602.8 Add 0.5 to 2.0 percent to the minimum excess oxygen level found in Section 602.7 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.

602.9 If the load of the combustion unit varies significantly during normal operation, repeat Sections 602.1-602.8 for the 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 the best performance over the range of the firing rates. If one firing rate predominates, the setting should optimize the conditions at that rate.

602.10 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 Section 602.5 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.

603 PROCEDURES FOR TUNING NATURAL AND INDUCED DRAFT BOILERS, STEAM GENERATORS, AND PROCESS HEATERS

603.1 Preliminary Analysis

a. Check the Operating Pressure or Temperature. Operate the boiler, steam generator, or process 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. Check Thermal Insulation. Check condition of, or absence of, appropriate insulation on all steam, hot water or process pipes, return tank, heat exchangers, storage tanks, etc. Lack of adequate thermal insulation will significantly increase fuel usage.
f. Combustion Analysis. Perform an "as is" flue gas analysis (O_2, CO, CO_2, etc.) with a warmed up boiler, steam generator, or heater at high and low fire. In addition to data obtained from combustion analysis, also record the following:
    1. Inlet fuel pressure at burner (at high and low fire)
    2. Draft above draft hood or barometric damper
        i. Draft hood: high, medium, and low
        ii. 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:

603.2 Checks and 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 and Heat transfer Surfaces. External and internal build-up of sediment and scale of the heating surfaces creates an insulating effect that quickly reduces unit efficiency. Excessive fuel cost will result if units are not kept clean. Clean tube surfaces, remove scale and soot, and assure proper fluid 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.

603.3 Safety Checks

a. Test primary and secondary low water level controls.
b. Check operating and limit pressure and temperature controls.
c. Check safety valve pressure and capacity to meet boiler, steam generator, or process heater requirements.
d. Check limit safety control and spill switch.
e. Check pilot safety shut-off operation.

603.4 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 rated capacity. Record fuel manifold pressure.
b. Adjust draft and/or fuel pressure to obtain acceptable, clean combustion at high, medium and low fire. Carbon monoxide value should always be below 400 ppm at 3% O_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 the range of firing rates. When above adjustments and corrections have been made, record all data.

603.5 Final Test

Perform a final combustion analysis with a warmed up boiler, steam generator, or process heater at high, medium, and low fire. 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 tuneup was performed.