

Boiler Tune-up Guide

National Emission Standards for Hazardous Air Pollutants for Area Sources:
Industrial, Commercial, and Institutional Boilers

40 CFR Part 63 Subpart JJJJJJ

The purpose of this Guide is to provide the boiler owner the knowledge base to appropriately direct boiler tune-up activities to comply with the requirements of the Boiler Area Source Rule. This will allow the boiler owner to clearly define the scope of work the tuning technician will be tasked to accomplish.

What is a boiler tune-up?

- A *boiler tune-up* refers to many aspects of improving boiler operations. In this Guide, the term *boiler tune-up* specifically refers to the activity to meet the requirements in the Boiler Area Source Rule (**40 CFR Part 63 Subpart JJJJJJ**).
- The tune-up activity is the act of reestablishing the air-fuel mixture for the operating range of the boiler. Oxygen and unburned fuel (carbon monoxide is generally the indicative measurement) are balanced to provide safe and efficient combustion. Carbon monoxide (CO) concentrations are also measured to ensure proper burner operation.
- A primary goal of a boiler tune-up is to improve boiler efficiency with respect to combustion operations.

What are the tune-up requirements under the Boiler Area Source Rule?

- See §63.11223(b) for the actual requirements.
- See the **Tune-up Guidance and Example Recording Form – Area Sources** posted at <http://www.epa.gov/stationary-sources-air-pollution/compliance-industrial-commercial-and-institutional-area-source> for information on compliance dates, recordkeeping, and reporting requirements.

Who should perform the actual tune-up?

- **All boiler adjustments and modifications should be completed by qualified, experienced technicians.**
 - Boiler operations in general and tune-up activities in particular are hazardous and require the skill and knowledge of experienced technicians.
 - The tune-up technician should be skilled in the evaluation and adjustment of the specific boiler and burner equipment in use.

What are the basic activities and minimum requirements associated with a boiler tune-up?

The following is a simple checklist that highlights the basic activities and requirements associated with a boiler tune-up to comply with the requirements of the Boiler Area Source Rule. The checklist is intended to be a time ordered tool to aid in planning and conducting boiler tune-ups.

1) Preparation

- a) Clearly identify the target equipment along with the intent and goals of the tune-up.
- b) Assemble boiler drawings and data sheets.
- c) Assemble burner drawings and data sheets.
- d) Assemble combustion control information.
- e) Identify environmental regulations and limitations.
 - i) Typically nitrogen oxides (NO_x) and combustible material (often identified as CO) are specifically addressed in the emission limits.
- f) Identify steam production control strategy that will be used during the tune-up.
- g) Identify in-situ instrumentation and verify calibration.
- h) Identify measurement locations and verify access.
 - i) The most common flue gas measurement location is immediately downstream of the steam generation section of a water-tube type boiler. For a fire-tube type boiler the flue gas sample is most commonly taken as the exhaust gases exit the boiler proper.
- i) Establish tune-up timeframe.

2) As-found observation

NOTE: Identification of the as-found conditions centers on measurement of the operating parameters of the combustion process that will be modified during the tune-up process. The primary measurements required under the Boiler Area Source Rule are flue gas oxygen content and flue gas carbon monoxide content at the high-fire or typical operation load.

- a) Examine the combustion control components (i.e., the system controlling the air-to-fuel ratio) and ensure it is functioning properly.
- b) Examine the burner internal components and identify any defects, if applicable.
- c) Examine the general boiler conditions and identify any defects.
- d) Measure and record the following for each operating position of the combustion control system.
 - i) Observe flame pattern, flame dimensions, and burner condition.
 - ii) Flue gas oxygen content.
 - iii) Flue gas carbon monoxide (CO) content.
 - iv) Flue gas emissions content (NO_x, if appropriate).
 - (1) Additional flue gas component analysis is required when the environmental permit specifies limits on emission components. A common regulated emission component is nitrogen oxides (NO_x).
 - v) Emissions control settings.
 - (1) Flue Gas Recirculation flow settings (if applicable).
 - vi) Final flue gas temperature.
- e) Document any modifications completed at this point.

3) Tune-up

The tune-up activity is the act of ensuring the burners are properly mixing the air and fuel and of reestablishing the most appropriate amount of excess air throughout the operating range of the boiler.

- a) Tune-up each operating position of the combustion control system (from high-fire through low-fire).

NOTE: The rule [63.11223(b)(4)] only requires that the tune-up be conducted at high-fire or the typical operating load.

- i) Establish steady operation for the target operating point.

- ii) Adjust combustion control position relationship to achieve desired combustion characteristics.
 - (1) Flue gas oxygen content - target will generally be the manufacturer's specifications.
 - (2) CO content - target will generally be the manufacturer's specifications.
 - (3) NOx content, if applicable – target will generally be the limit specified in the environmental permit.
 - (a) Adjustments for emissions control are generally completed after combustion adjustments are established.
- iii) Measure and record the following for each operating position of the combustion control system.

NOTE: Only the high-fire or typical operating load need to be recorded to comply with the rule [63.11223(b)(6)].

- (1) Observe flame pattern, flame dimensions, and burner condition.
- (2) Flue gas oxygen content.
- (3) Flue gas CO content.
- (4) Flue gas emissions content (NOx and others).
- (5) Final flue gas temperature.
- iv) Document any modifications completed at each point.

4) Document tune-up.

- a) Document the tune-up including the following.
 - i) As-found conditions.
 - ii) Post tune-up conditions.
 - iii) Modifications and repairs completed.
 - iv) Recommended investigations and modifications.
 - v) Identified shortcomings of the equipment.

Additional Guidance

What if manufacturer's specifications are not available?

The appropriate range within which to manage excess oxygen depends on the fuel type and the method of monitoring and controlling flue gas oxygen content. The following table provides some general information of the typical control limits for steam boilers. The data represented in this table indicates the expected operating range for boilers.

The numerical values in the table represent the amount of oxygen (O₂) in the flue gas as it exits the combustion zone. This is the actual field measurement for most boilers and it is the common control parameter. The oxygen concentrations noted in the table are "wet basis" measurements and "dry basis" measurement). The rule [§63.11223(b)(5)]) allows measurements on either a dry or wet basis as long as it is the same before and after the adjustments are made.

The two designations in the table are *automatic control* and *positioning control*. *Positioning control* is generally not equipped with continuous flue gas oxygen measurement. The more efficient control is *automatic control*. *Automatic control* (or *continuous automatic control*) continually monitors oxygen content and combustion air flow is trimmed to maintain required oxygen limits, sometimes referred to as *oxygen trim control*.

Typical Flue Gas Oxygen Content Control Parameters								
Fuel	Automatic Control				Positioning Control			
	Flue Gas O ₂ Content				Flue Gas O ₂ Content			
	Minimum		Maximum		Minimum		Maximum	
	Wet Gas Sample [%]	Dry Gas Sample [%]	Wet Gas Sample [%]	Dry Gas Sample [%]	Wet Gas Sample [%]	Dry Gas Sample [%]	Wet Gas Sample [%]	Dry Gas Sample [%]
Natural Gas	1.5	1.8	3.0	3.6	3.0	3.6	7.0	8.0
No. 2 Fuel Oil	2.0	2.2	3.0	3.3	3.0	3.3	7.0	7.6
No. 6 Fuel Oil	2.5	2.8	3.5	3.8	3.5	3.8	8.0	8.5
Pulverized Coal	2.5	2.7	4.0	4.3	4.0	4.3	7.0	7.4
Stoker Coal	3.5	3.7	5.0	5.3	5.0	5.3	8.0	8.4
Stoker Biomass-Wet	4.0	5.2	8.0	9.7	5.0	6.4	8.0	9.7
Stoker Biomass-Dry	4.0	4.4	8.0	8.6	5.0	5.5	8.0	8.6

Additionally, it should be noted that flue gas oxygen content targets may be influenced by environmental controls; such as, nitrogen oxides (NO_x) control. When a boiler is equipped with NO_x control the minimum oxygen concentrations are sometimes higher than if the boiler was equipped with a standard burner without NO_x control.

What tools or methods can be used to measure oxygen and CO?

The primary tool required to complete a boiler combustion tune-up is a flue gas analyzer. The required measurements for an appropriate flue gas analysis are flue gas oxygen content, combustibles content, and any components that are managed as a part of environmental compliance (NO_x for example). These measurements are typically obtained with a portable combustion analyzer.

NOTE: This Guide is in no way intended to advise a departure from the boiler or burner manufacturer's instructions and recommendations.

What if I need more detailed information on performing a boiler tune-up?

- ***For More Information:*** Boiler Tune-up Guide for Area Source Boiler Owners is based on the Boiler Tune-up Guide for Natural Gas and Light Fuel Oil Operation, prepared by Greg Harrell, DOE's Energy Management Services which presents:
 - A general discussion of boiler efficiency and the influence combustion control has on efficiency.
 - The basic combustion control methods.
 - The typical field activities associated with tuning a boiler.
 - The methods for evaluating the economic impact associated with tuning a boiler.
 - A basic discussion of the environmental impacts that can be expected with a boiler tune-up activity.
 - General reference data that can be useful in boiler tune-up evaluations
 - A list of general references that may prove useful in tune-up activities.
- This Guidebook can be found at:
<https://www.epa.gov/stationary-sources-air-pollution/industrial-commercial-and-institutional-area-source-boilers>