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INSPECTION MANUAL FOR ENFORCEMENT OF NEW SOURCE PERFORMANCE STANDARDS

BASIC OXYGEN PROCESS FURNACES

U.S. ENVIRONMENTAL PROTECTION AGENCY
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INSPECTION MANUAL FOR ENFORCEMENT OF NEW SOURCE PERFORMANCE STANDARDS: BASIC OXYGEN PROCESS FURNACES

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1.0 INTRODUCTION

In accordance with Section 111 of the Clean Air Act, the Administrator of the U.S. Environmental Protection Agency (EPA) promulgated particulate standards of performance for new and modified basic oxygen process furnaces. The standards became effective 8 March 1974 and apply to sources the construction or modification of which was commenced after 11 June 1973. The standards are applicable to each basic oxygen process furnace and limit discharge into the atmosphere of any gases which contain particulate matter in excess of 50 mg/dscm (0.022 gr/dscf.) For a complete discussion of standards, see Appendix A.

Under these new source performance standards, a performance test must be conducted on any new or modified basic oxygen process furnace to ensure that control equipment is designed and installed which will provide compliance with the standard. After determining that the facility with its control equipment does, in fact, comply with the standards, it is the further intent of the regulations that the equipment not be allowed to deteriorate to the point where the standards are no longer maintained. In fact, a specific provision of the regulations, 40 CFR 60.11(d), provides that affected facilities shall be operated and maintained "in a manner consistent with good air pollution control practice for minimizing emission."

The purpose of this manual, therefore, was to provide the air pollution inspector with necessary information so that he could determine whether or not a furnace was still in compliance for some period of time after the conduct of initial performance tests. To provide for this continuing enforcement of emission standards, the Division of Stationary Source Enforcement of the U.S. Environmental Protection Agency properly anticipated the need for a series of field inspection manuals, which could be used by an inspector to assist him in determining whether a pollution source was complying with all applicable regulations. While this manual was developed primarily to meet the need for enforcement of EPA's new source performance standards, it was intended that the information contained herein would be equally useful for enforcement of state regulations applicable to all existing basic oxygen process furnaces.

In both cases the regulations may be enforced by either Federal or state air pollution control authorities. Each state may develop a program for enforcing the Federal new source performance standards applicable to sources within its boundaries. If the proposed program is adequate, EPA will delegate implementation and enforcement authority to the state for all affected sources with the exception of those owned by the U.S. Government. Also, each state was required to submit implementation plans to EPA in 1971 that included emission regulations which would reduce emissions and ensure attainment and maintenance of the ambient air quality standards (Section 110 of the Clean Air Act.) If the regulations are not enforced at the state level, then EPA is legally obligated to enforce the State's Implementation Plan. If a Federal inspector observes a violation of a state's regulation adopted under the State Implementation Plan, he can enforce the SIP regulation.

The scope of this manual includes all operations normally associated with basic oxygen process furnaces. The standards apply only to basic oxygen process furnaces. Other pollutant sources in the iron and steel industry are covered by other standards.

This manual includes a description of the process, a discussion of process control and emission instrumentation normally found at BOF plants, startup and shutdown problems, an analysis of the malfunctions that affect air pollution emissions, operating parameters that are important from the inspector's viewpoint, a step-by-step inspection procedure which Federal (or State) enforcement officials should follow, and recommendations for observing performance tests (stack tests). Accompanying appendicies include supplemental reference materials of importance to the inspector.

This manual was prepared from information previously published on basic oxygen process furnaces, from stack tests of several furnaces at iron and steel plants, from applicable rules and regulations promulgated by EPA and published in the Federal Register and from past experiences of the air pollution control staff of Engineering-Science, Inc. The assistance of staff from the Division of Stationary Source Enforcement was particularly helpful in providing direction for the project.

2.0 NSPS AND SIP REQUIREMENTS

2.1 NEW SOURCES--NSPS

The Federal emissions regulations applicable to new or modified basic oxygen process furnaces are called New Source Performance Standards (NSPS). They are published in the Code of Federal Regulations under Title 40 CFR Part 60. The standards require control at a level typical of a well controlled existing steel mill and are attainable with existing technology. To determine the emission level which should be selected as the standard, extensive on-site investigations were conducted and design factors, maintenance practices, available test data, and the character of stack emissions were considered by EPA. Economic analyses were also conducted prior to promulgating the standards. The EPA document which provides background information on the derivation of the standards is entitled "Background Information for Proposed New Source Performance Standards" (7).

Provisions of the regulation are applicable to each basic oxygen process furnace. A basic oxygen process furnace is defined as any furnace producing steel by charging scrap steel, hot metal, and flux materials into a vessel and introducing a high volume of an oxygen-rich gas. On and after the date on which the performance test required to be conducted by paragraph 60.8 is initiated but no later than 180 days after initial startup, no owner or operator subject to the provisions of the regulations shall discharge or cause the discharge into the atmosphere from a basic oxygen process furnace any gases which contain particulate matter in excess of 50 mg/dscm (0.022 gr/dscf). Opacity standards have not been promulgated for basic oxygen furnaces.

2.2 EXISTING SOURCES--SIP

Under the 1970 Clean Air Act amendments, each state in 1971 had to file with EPA a State Implementation Plan which included emission regulations to achieve and maintain ambient air quality standards. As a result of those implementation plans and efforts to meet ambient air quality standards by 1975 through 1977, states have developed emission limitations for practically all industries that, when controlled, would help achieve the ambient air quality goals. EPA encouraged some uniformity and reasonable stringency of the standards by publishing suggested standards as Appendix B of a regulation on preparation of State Implementation Plans (23). In the case of particulate emissions, EPA published a reference process weight table (Table 2.1) representative of data from the state and local regulations. Thus, Federal standards are stated with respect to grain loading in the emitted gas while the state standards are generally stated with respect to the mass emissions per unit of material processed.

State or local agencies do not normally have an emission standard specifically for the basic oxygen process furnaces. Instead, process weight regulations are commonly employed to limit particulate emissions from a variety of industrial sources. However, the actual limits vary from state to state so Table 2.1 should be considered illustrative only and should not be referenced for enforcement purposes. Furthermore, state regulations are frequently modified and may contain qualifications, exceptions or special provisions for certain source categories.

Table 2.1 REPRESENTATIVE DATA FROM PROCESS WEIGHT CURVE

Process weight rate, lb/hr	Allowable emission rate, lb/hr
50	0.36
100	0.55
500	1.53
1,000	2.25
5,000	6.34
10,000	9.73
20,000	14.99
60,000	29.60
80,000	31.19
120,000	33.28
160,000	34.85
200,000	36.11
400,000	40.35
1,000,000	46.72

By definition process weight per hour means "the total weight of all materials introduced into a special process that may cause any emissions of particulate matter" to the atmosphere. In some industries, the definition of process weight is somewhat complicated. However, for the basic oxygen process and steel making industry, the process weight referes mainly to the amount of hot metal and the amount of scrap added to the vessel which sums to the production rate. Fluxes added to the furnace later in the cycle constitute less than 1/2 of one percent of the process weight. These quantities are normally recorded in an operator's daily log for each heat produced at a steel plant.

Basic Oxygen Process Furnaces (BOPF) have steel production capacities between 100 and 325 tons per heat; one BOPF cycle is commonly referred to as a heat. A typical 140 ton furnace has a cycle time of approximately 40 minutes. These furnaces would have a process weight rate of approximately 200 tons per hour. Therefore, a process having a process weight rate of 200 tons per hour would be permitted to emit a maximum of 40.35 pounds per hour of particulate matter to the atmosphere.

The pollutant of most concern with respect to the existing standards and this operation is particulate matter (grain loading). Particulate concentration is limited to a maximum of 50 milligrams per dry standard cubic meter (0.022 grains per dry standard cubic foot.) This standard refers to that portion of the heat beginning with the oxygen blow and ending just prior to tapping. Reblows are included but charging, testing and pouring are not covered by this regulation. Results of tests conducted by the U.S. EPA have demonstrated that the 50 mg/dscm (0.022 gr/dscf) is a practical standard since many of the new steel plants currently operating in this country today have little difficulty in achieving that standard.

Opacity regulations of most states apply to all point sources regardless of whether the emission is discharged from a stack. Opacity limitations in some states may apply to fugitive dust sources.

2.3 APPLICABILITY OF STANDARDS

Emission standards are specifically referenced to the basic oxygen process furnace and do not apply to the electric arc or open hearth steel-making processes. Other New Source Performance Standards were promulgated by the U.S. EPA for the electric arc furnace at 40 FR 43852 (September 23, 1975). The BOPF emission standards apply to the concentration of particulate matter in the gas stream associated with the steel-making operation by the BOPF which begins after the oxygen lance is inserted and ends prior to tapping. The heaviest concentration of particulate emission occurs during the oxygen-blowing period.

The New Source Performance Standards apply to each basic oxygen process furnace used in iron and steel plants. Moreover, the standards apply after a new facility has been started up and reached some degree of equilibrium. For the first performance test, the owner must give 30 days advance notice to the Administrator of EPA. The standards are not applicable during startup, shutdown and malfunction since these periods do not constitute representative operating conditions. However, as will be described later, the owner must report all excess emissions on a quarterly basis although NSPS address only stack emissions and not fugitive emissions. Also, the regulations ensure that plant operators properly maintain and operate the affected facility and control equipment between performance tests including the periods of startup, shutdown and unavoidable malfunction.

In addition to the BOPF, steel mills recently have begun utilizing the Q-BOP furnace. The primary difference between the Q-BOP and BOPF is that the Q-BOP has no lance; the oxygen is introduced into the furnace through tuyeres in the bottom of the vessel. The NSPS requirements are not applicable to the Q-BOP furnace, however, inspectors should be aware that this process is in commercial use and many Q-BOP's will probably be installed over the next several years. Sufficient information and data has not been developed at this time to discuss inspection procedures for the Q-BOP furnace. When such information is available, it will be published as an addendum to this report.

One of the more difficult subject areas to determine is the applicability of the standards to existing sources which undergo modification. Under the revised regulations the definition of affected facility is limited to an apparatus to which a standard applies. "Modification" means any physical change in, or change in the method of operation of, an existing facility which increases the amount of any air pollutant (to which a standard applied) emitted into the atmosphere by that facility or which results in the emission of any air pollutant (to which a standard applied) emitted into the atmosphere not previously emitted. The definition of modification and other questions of applicability are fully discussed at 40 FR 58416 (December 16, 1975)(9).

A recommended procedure is offered in Section 6.0 of this manual for Federal and state enforcement officials to inspect a basic oxygen process furnace of a steel plant. The enforcement of state standards and Federal standards are nearly the same except that the nature of the emission standards is different. The Federal standard is written with respect to grain loading or stack gas concentration and the state standards are generally written in terms of the mass emissions from this type of process.

3.0 PROCESS DESCRIPTION, ATMOSPHERIC EMISSIONS, AND EMISSION CONTROL METHODS

Existing technology for producing steel in this country centers around three different furnaces: the open hearth, electric arc, and basic oxygen process furnace (BOPF). The open hearth furnace uses an oil or gas flame and air jet to convert solid and molten iron into steel. This process is relatively slow and the amount of raw steel produced by this method has decreased from 84% in 1962 to 37% in 1970. Electric furnaces are generally charged with scrap and alloys to produce a variety of specialty steels and other high grade metals. The heat is produced by an electric arc between the electrode and the metal. Steel production by the electric arc furnace increased from 9% in 1962 to 15% in 1970. The basic oxygen process furnace converts molten pig iron and scrap to steel by blowing large quantities of oxygen into the charge. The principle advantage of this system over the open hearth is its higher production capacity. Undoubtedly, new steel mills desiring additional steel production capacity in this country will build BOPF or electric arc furnaces in lieu of open hearth furnaces.

The basic oxygen process furnace is a major operation in the integrated iron and steel industry. It is unlikely that an enforcement official would have to contend with a basic oxygen furnace in any manufacturing plant other than at an integrated iron and steel facility. On the other hand, blast furnaces, sintering plants, and even electric arc steel furnaces can be found separately in different shops throughout this country.

3.1 PROCESS DESCRIPTION

Basic raw materials for the BOPF consist of hot molten metal pig iron produced by a blast furnace and scrap. Steel is produced by lowering the carbon, manganese and silicon contents of pig iron by oxidation at elevated temperatures to levels desired for the particular brand of steel. Impurities, such as sulfur and phosphorus, are also lowered by using fluxes of appropriate composition. Steel scrap, flux and hot metal are charged into the furnace lined with a refractory material. The steel scrap consists mainly of billets and slabs, compacted automobiles, and even recirculated metal. The hot metal comes from the blast furnace and is usually brought in the molten state to the BOPF by means of submarine ladle cars. The basic oxygen process furnace is also known as the oxygen blown steel-making process. (It should be noted that oxygen may also be used in the open hearth process to increase production rates.) High purity oxygen (95% or better) is blown into the molten metal bath in the vessel. The BOPF is a vertical cylindrical container open on the top end and about 20 feet in diameter at its widest point. It is pear-shaped as depicted in Figure 3.1. The BOPF is charged through the top and a water-cooled lance is lowered during the oxygen blowing. The vessel is tilted to facilitate operations which include charging, slagging, tapping, and pouring. Sixteen steel companies have 34 of the 36 BOPF's in the U.S. today.

The charge is generally 25 to 35% scrap metal, and 65 to 75% molten pig iron. The scrap is charged first and may be preheated by the combustion of natural gas introduced into the vessel by the lance. Charging is completed by the introduction of flux and molten pig iron. The blowing portion of the heat occurs when oxygen is introduced into the molten charge through the lance at sonic speeds. The amount of oxygen varies slightly and depends on the quantity of impurities and grade of steel desired but is on the order of 2,000 scf/ton of steel produced. The oxygen combines with the iron and carbon in an exothermic reaction (a chemical reaction which liberates heat) thus precluding any requirement for external heating of the vessel. The oxygen blowing is carried out at sonic velocity so as to provide sufficient agitation of the molten charge to melt the scrap and provide a good thermal reaction. The blowing lasts about 20 to 25 minutes on a 250-ton vessel, at the end of which time the vessel is tilted to obtain a sample and the steel composition is spectrographically analyzed by computers. If the analysis indicates that the composition has not been reached the vessel is tilted to the upright position and a reblow takes place. Reblow generally occurs about every third heat and will last about 5 minutes. When the desired composition is reached (mainly depending on the carbon content of the steel), the steel is poured into a ladle where it is subsequently poured into molds. The cycle time depends on the process, but is generally about 40 to 45 minutes.

Furnace capacity varies greatly and in the U.S. typical ranges are between 100 and 325 tons capacity per heat with production rates between 150 and 500 tons per hour. The trend in new units is towards larger furnaces.

For a more complete description of the operations of a basic oxygen process furnace, please refer to:

- A Systems Study of the Integrated Iron and Steel Industry (2)
- Air Pollution Aspects of the Iron and Steel Industry (3)

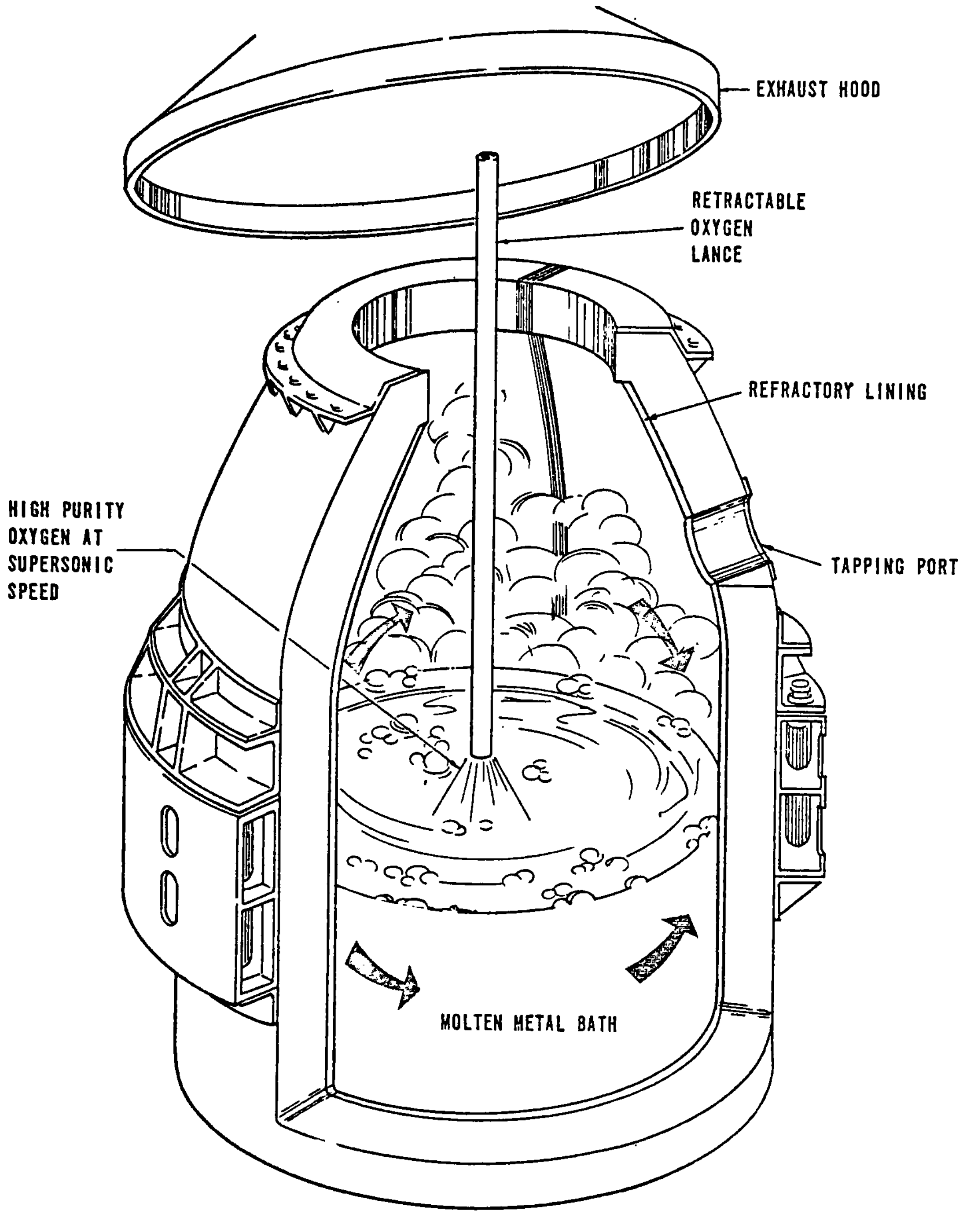

Figure 3.1 Basic oxygen process furnace

- Background information for Proposed New Source Performance Standards (7)

3.2 ATMOSPHERIC EMISSIONS

Potential atmospheric emissions associated with basic oxygen process furnaces are formed when a water-cooled lance impinges oxygen at high velocity on the hot metal and scrap charge to cause violent agitation and mixing of oxygen with molten iron. Rapid oxidation of carbon, silicon, manganese, and some iron occurs. Fumes and gaseous emissions emanate from the mouth of the converter and enter the hood during the oxygen blow. Highest emissions occur during this oxygen-blowing period.

Emissions from the BOPF unit also occur during charging, fluxing, slagging, metal testing, and tapping. Charging of the molten pig iron and tapping are by far the largest of these lesser stages of the heat. The vessel is tilted for these two operations and, as a result, some particulate (reddish brown in color) escapes the hood and passes through the roof monitors. During charging, when the hot pig iron comes in contact with the cool scrap metal, a fine silver-like dust known as kish is emitted. Kish is also emitted from the ladle when the hot metal surface is skimmed prior to charging to the furnace. Kish consists of angular flakes of graphite having smooth surfaces. The emission of kish may include coarse fragments of opaque magnetic iron oxide particles, rounded particles of red iron oxide, and traces of quartz and calcite. The kish is uncontrolled, yet because of its density, it can become airborne.

The silica fume that occurs in the early part of the blow is collected as a grey to off-white material. It often contains small amounts of iron, manganese, and carbon.

Later, during the BOPF blow, the predominant particulate emission is reddish-brown iron oxide. The particulates are rounded, transparent, smaller than 1 micron, and tend to agglomerate. Some fine, black spheres of magnetite are present and are covered with red iron oxide. If galvanized scrap is part of the charge, zinc oxide in the collected dust makes the dust unsuitable for sintering for feed to the blast furnace.

The fineness of the BOPF particulates makes them difficult to measure. As a result, size analyses have varied widely. Reports show (1) 95 per cent are smaller than 1 micron, with a median of 0.45 micron, and (2) 99 per cent smaller than 0.2 micron, with a median of 0.065 micron. Another recent report gives a median diameter of 0.012 micron. Another report states that 20 per cent are smaller than 0.5 micron, 65 per cent are between 0.5 and 1.0 micron, and 15 per cent are between 1.0 and 1.5 microns.

The dust concentration (as reported by one source) varied from 2.02 to 4.96 grains/scf. Another source states that dust concentrations range up to 20 grains/scf. The volume of exhaust gas (at temperature of combustion) is about 25 times greater than the volume of oxygen blown for combustion hood designs. The amount of dust per net ton of raw steel was reported in 1959 to range from 14.5 to 27.4 pounds/ton. In 1968, an average of 40 pounds per ton was reported by one plant. Others state it is 1 to 2 per cent of the weight of the metallic charge.

In the Stora-Kaldo Oxygen Process, a cylindrical vessel is rotated in almost a horizontal position. Operating principles are similar to those for the upright BOPF vessels. More scrap can be charged than in the BOPF, but the heat time is longer. The Sharon Steel Corporation has the only two Kaldo furnaces in the United States, rated at 150 tons per heat. The size of particulate emissions is reported to be larger than particulate emissions from the BOPF; only 6 per cent is smaller than 1 micron, probably as a result of agglomeration. About 10 pounds of dust are said to be generated per net ton of raw steel produced.

The standard of performance that has been set by the U.S. EPA restricts particulate emissions to the atmosphere from the beginning of the oxygen blow until just prior to tapping. The ancillary operations are not easily controlled and also are not regulated by the U.S. EPA, but some states are requiring operating practices which minimize dust and visible emissions during these ancillary phases.

During the oxygen-blowing process, exhaust gases leave the mouth of the converter to be captured in the hood system. The temperature of the gases leaving the furnace is several thousand degrees F so the exhaust must be cooled before entering any air pollution control device. The exhaust gases contain iron oxide as described above but also may contain carbon monoxide. In this country, two types of capture systems have traditionally been used to collect the exhaust gas as it leaves the vessel: the closed hood (also known as a movable hood) and combustion hood. For a system which utilizes a combustion hood, the iron is oxidized to Fe_2O_3, while for the BOPF shops using a closed hood (movable hood) the iron is just partially oxidized to FeO. In the combustion hood most of the carbon monoxide emitted from the vessel is converted to a non-explosive carbon dioxide in the upper portion of the hood. For a closed hood system, carbon monoxide is a major constituent of the exhaust gas all the way to the scrubber exhaust stack. The iron oxide dust is very fine with both hoods but is somewhat larger in BOPF using movable hoods. Particle size ranges from 0.01 to 10.0 μ for combustion hoods and 0.5 to 30.0 μ for movable hoods.

While there are several process factors which can affect air pollution emissions from the basic oxygen process furnace, the two most important operating variables are oxygen-blowing rate and steel production rate. Naturally, larger vessels can be expected to emit more contaminants (on the basis of mass emissions) to the atmosphere than smaller vessels. Very seldom do steel companies use other than design capacities during their production schedules. In other words, an inspector does not have to worry about a half charge or quarter charge to the vessel when he visits the plant. If the unit is designed for 250 tons per heat, it is likely that the charge will be of that quantity. Typical operating capacities from each plant/vessel can be obtained from operators' daily logs which are routinely kept at each shop.

The emissions from the BOPF are governed by the oxygen-blowing time and oxygen-blowing rate. It has been noted that approximately 1,800 to 2,000 cubic feet of oxygen are required for each ton of steel produced. Different types of steel will require different amounts of oxygen. The oxygen-blowing time is about 25 minutes including reblows. A reblow may be required after the vessel has been turned down and the metal spectrographically analyzed if it does not have the proper carbon content. A reblow may last 5 to 10 minutes.

3.3 EMISSION CONTROL METHODS

The best controlled BOPF plants in the U.S. will either have high energy venturi scrubbers or electrostatic precipitators to reduce particulate emissions to acceptable limits. There are three combinations of hood arrangement and abatement devices that are traditionally used for the BOPF facilities. These include:

Combustion Hood, High Energy Venturi Scrubber
Combustion Hood, Electrostatic Precipitator
Closed Hood, High Energy Venturi Scrubber

High concentrations of combustible carbon monoxide make the hot gases potentially too hazardous to clean in the arcing electric field of an electrostatic precipitator when using the closed hood system. Figures 3.2 and 3.3 illustrate the overall abatement system involved in capturing particulate emissions emanating from a BOPF operation. The system utilizing a closed hood will flare carbon monoxide gases at the stack exit although some foreign plants have used the carbon monoxide gas stream from the BOPF for the production of process steam. Smaller volumes of exhaust gases will be treated with a closed-hood, high-energy venturi system than with the other two combustion hood systems. All three combinations mentioned above, had been tested prior to enactment of the particulate concentration emission regulation for the BOPF. Furthermore, all present systems are capable of attaining the U.S. EPA New Source Performance Standards for the BOPF.

From the air pollution control viewpoint, the major problem associated with the BOPF is particulate matter and the abatement equipment. In reality, this problem is one of maintenance rather

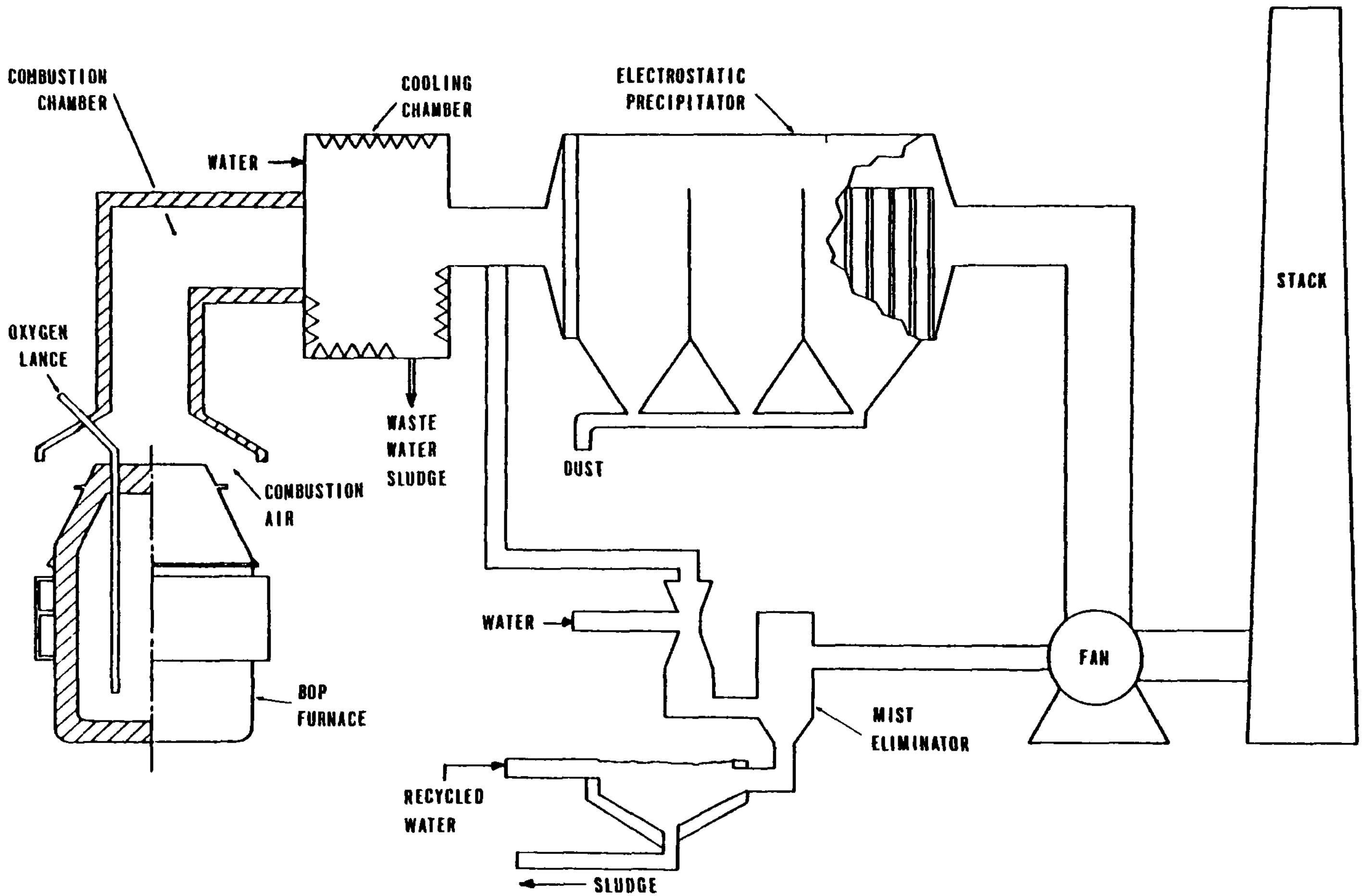

Figure 3.2 Controlled basic oxygen process furnace, open hood with scrubber or electrostatic precipitator

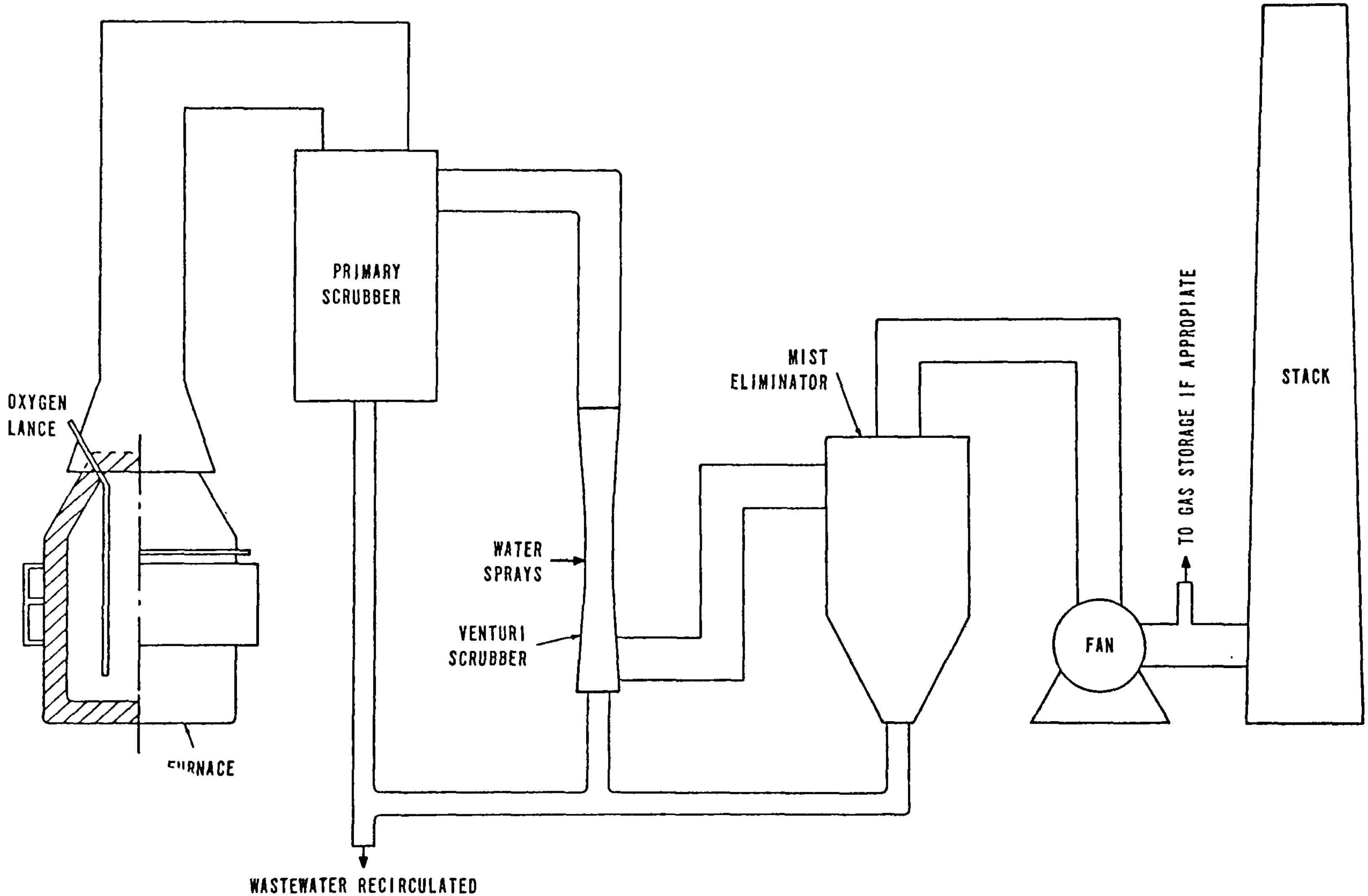

Figure 3.3 Controlled basic oxygen process furnace, closed hood with scrubber

than design parameters. It has successfully been proven that application of currently available air pollution technology, will result in compliance with applicable Federal and state emission standards.

Energy requirements for a 60-inch pressure drop venturi with a 50,000 cfm gas flow rate is about 800 horsepower. In modern steel mills, the abatement equipment is an important part of the BOPF operation and malfunction of a precipitator or scrubber would soon be noticed due to the resulting visible emissions. In other cases, the plant would continue to operate with limited control available during malfunction. Operators would not exhaust these gases untreated to the atmosphere since they are easily distinguishable. Instrumentation is commonly employed and almost all steel mills will have a routine maintenance schedule for the air pollution abatement equipment.

One of the critical factors which applies to both types of control devices (scrubbers and precipitators) is the gas temperature entering the unit. Gas temperatures at the mouth of the furnace average about 2,800°F. Cooling is mandatory before the gases enter either a precipitator or venturi scrubber and is accomplished with a series of water sprays controlled automatically by temperature sensors. Certain banks of water sprays are activated as the temperature increases from the first portion of the oxygen-blowing period. Generally, the gas temperature entering the precipitator or venturi scrubber ranges between 300 and 500°F. Higher temperatures will cause reduced efficiencies due to the temperature effect on particulate resistivity with electrostatic precipitators and may also cause adverse operation of the venturi scrubber.

There are several operational control features of an electrostatic precipitator which are important in cleaning the effluent gas. The spark rate of a precipitator for a BOPF installation should range between 75 and 125 with an average of about 100 sparks per minute. Spark rate meters have traditionally been installed on modern precipitators as an indication of their operating performance to the manufacturers. Some of the newer precipitators will use the spark rate to automatically adjust the primary and secondary voltages to certain sections in order to maintain a uniform cleaning efficiency. The spark rate from each section of the precipitator would be the quickest indication whether any abnormal conditions exist for this abatement device.

Other instrumentation which exists on electrostatic precipitators include the primary and secondary voltage meters. In this case, specific quantities indicating voltage cannot be universally applied to all precipitators controlling BOPF emissions. At best, the primary and secondary voltage meters will indicate if there are any "dead" sections present. In a similar fashion, ampere meters on precipitators would indicate the operability of certain sections within the precipitator. BOPF precipitators will have 20 to 50 sections and, if several are "dead", the overall collector efficiency is reduced.

Other instrumentation may include a device to determine the velocity of the gas stream entering the precipitator. To maintain a desired efficiency, the flow rate through a precipitator must be uniform. By changing the velocity by a factor or two (from the design velocity), the efficiency may decrease by as much as 20%.

Temperature sensors are usually connected to alarms to prevent severe damage to a precipitator or scrubber in the event that the inlet gas temperature becomes too high. Several steel plants have bypasses which would exhaust the gas, untreated, to the atmosphere in the event that the temperature exceeded the designed operating condition for the precipitator. Changes in temperature and moisture will alter the resistivity of the BOPF dust.

Venturi scrubbers have fewer operating control variables than a precipitator for BOPF installations. Of prime importance on scrubbers is the pressure drop. For removing the small diameter particulate that is associated with the BOPF steel-making operation, high energy venturi type scrubbers must be used. This refers to pressure drops between 60 and 75 in wg. Some venturi systems have twin throats and some might even be equipped with variable throats. At any rate, the pressure drop across the entire system should be in excess of 60 in wg. Typical throat velocities which correspond to these pressure drops range from 200 to 600 ft/sec.

Almost all scrubbers will include manometers or other gauges which would indicate the pressure drop across the unit. Some plants may have manometers on the water injection nozzles at the throat. To a lesser degree, the water flow rate within the scrubber is important. For the BOPF installations, the water requirements for a venturi scrubber are about 3 gallons per minute per 1,000 scfm. Most modern steel plants will have monitoring systems that will record the pressure drop, water flow rate, and air flow rate to the scrubber.

Many plants whether using venturi scrubbers or electrostatic precipitators may have an opacity meter on the stack outlet. For safety precautions many steel plants will also monitor the exhaust gas in the duct for carbon monoxide, hydrocarbons, and temperature. For these BOPF installations, the opacity meter is an indication of particulate emission. Of the modern steel plants observed, continuous 24 hour charts were available for opacity on the BOPF stack.

Further detail on air pollution control equipment applications for basic oxygen process furnaces can be obtained from:

- Air Pollution Engineering Manual (4)
- Background Information for Proposed New Source Performance Standards (7)

- Air Pollution, Volume III, Sources of Air Pollution and Their Control (18)

- Control of Metallurgical and Mineral Dusts and Fumes in Los Angeles County (6)

- Control Techniques for Particulate Air Pollutants (10)

- Survey of Air Pollution from the Kaiser Steel Plant (22)

- Electrostatic Precipitator Technology (1)

- Air Pollution Manual, Part II, Control Equipment (5)

- An Outline of Metallurgical Practice (17)

- Wet Scrubber System Study (20)

4.0 MONITORING, RECORDKEEPING, AND REPORTING REQUIREMENTS

4.1 MONITORING THE PROCESS, CONTROL DEVICE AND EMISSIONS

One purpose of monitoring operations and maintenance of the basic oxygen process furnaces at iron and steel plants is to ensure that the compliance determined by performance tests is maintained on a continuing basis by proper operation and maintenance of all equipment.

From an air pollution control viewpoint, the major problem associated with steel making is efficient capture of particulate matter generated by the furnaces and subsequent removal of the particulate by abatement equipment. It has been positively shown that with current air pollution control technology, particulate emissions from these plants can be reduced to meet all applicable Federal and state emission standards. Thus assuming proper design of the abatement system, the problem becomes one of proper maintenance and use of the equipment.

At the present time, new source performance standards for new or modified basic oxygen process furnaces do not require any monitoring equipment on the processes, on the control equipment, or on the emissions discharged to the atmosphere. However, the process monitoring that will likely be found on a BOPF will be the temperature of the molten steel and the oxygen-blowing rate. The emission monitoring that will likely be found on a BOPF will be the measurement of carbon monoxide concentrations. Occasionally one may find opacity being monitored. The control equipment monitoring will be an integral part of the control equipment design and will typically identify pressure drops across the equipment, water use, electrical use, spark rate, etc.

Either specific or general monitoring requirements may be in effect under certain State Implementation Plans. However, EPA has not promulgated any minimum requirements for BOPF's.

4.2 RECORDKEEPING

Since automatic monitoring is not presently required for basic oxygen process furnaces, recordkeeping on a routine basis becomes extremely important to provide a method for the air pollution inspector to determine that operating and maintenance practices are consistent with reasonable air pollution control needs. Records should be kept on production processes, on control equipment and on emissions. Each of these parameters are described separately although obviously there are interrelationships.

Also, it should be clear that the suggested recordkeeping is not now required by the NSPS and probably not by any of the state agencies. Section 114(a)(ii) of the Clean Air Act, as amended, provides that the Administrator may require the owner or operator of any source to provide information for the purpose of determining "whether any person is in violation of any such standard or any requirement of such a plan." This is one of the most important enforcement tools under the Clean Air Act, in that the source can be required to provide the information which may be the basis for later enforcement by EPA.

The facility operator should maintain a description (tabulation and schematic diagrams) of the plant identifying major equipment items, types of furnaces, and controls used for steelmaking operations. Process instrumentation does exist at all steel mills and on a continuing basis records are kept of the amount of scrap and molten iron charged to the furnace and the amount of oxygen used per blow. These historical records will be of importance to the field enforcement official in assessing the operating status of the BOPF during his plant visit.

Within an integrated iron and steel mill, there may be three different types of furnaces: open hearths, electric arcs and basic oxygen processes. However, the types of records that will likely be maintained are similar. On each BOPF furnace, the following information should be recorded and very likely will be available in the company's records for each heat or batch:

(1) Quantity of pig iron and scrap charged, to nearest ton;

(2) Quantity of steel produced, to nearest ton;

(3) Specification of the steel ingot;

(4) Date and time heat began and ended, to nearest minute;

Errata: EPA 340/1-77-002. Basic Oxygen Process Furnace Inspection Manual
page 2-4
amend paragraph two to read: In addition to the BOPF, steel mills recently have begun utilizing the Q-BOP furnace. The primary difference between the Q-BOP and BOPF is that the Q-BOP has no lance; the oxygen is introduced into the furnace through tuyeres in the bottom of the vessel. The NSPS requirements are applicable to the Q-BOP furnace, however sufficient information and data has not been developed at this time to discuss inspection procedures for the Q-BOP furnace. When such information is available, it will be published as an addendum to this report.

(5) Oxygen consumption, to nearest 100 cubic feet;

(6) Fuel or compressed air consumption, if any, to nearest 100 cubic feet;

(7) Flux identification by constituents, and consumption, to nearest 100 pounds;

(8) Malfunctions;

(9) Operating deviations for above items.

The purpose of recording the above process data is to be able to compare the batch or heat production cycle at the time of inspection with the production at the time of the performance test. The emission rate for a given steel specification will increase if the heat is produced quicker by using more oxygen. Also, the capture efficiency of the hood would probably decrease as production rates increased above the performance tested production rate.

The exhaust gas collection, venting, and emission control system should be described (diagrammed) in detail. The sequence of controls and types of controls should be outlined and described using quantitative parameters. For each control system, the respective information listed below should be recorded at the intervals indicated:

(1) Quantity of collected dust and fume, by month to nearest ton;

(2) Volumetric flow on inlet to collector, on first of each month;

(3) Volumetric flow on outlet from collector, on first of each month;

(4) Pressure drop across the collector (venturi scrubber or electrostatic precipitator) after cleaning, on first of each month;

(5) Static pressure from fan through collector, gas cooling system and ductwork to collecting hood, on first of each month;

(6) Results of any carbon monoxide analyses, on first of each month;

(7) Inspections, maintenance and repairs, by month; and,

(8) Malfunctions, by month.

The purpose of having the above information kept on the air pollution control system is to ensure that air contaminants generated by the furnaces will be collected by the electrostatic precipitator, scrubber or other collection system the same as when the performance tests were conducted. The quantity of dust collected should remain proportional to the production of furnaces hooked to the system. The volumetric flow measurement on the inlet and outlet will indicate leaks in the precipitator or scrubbers. Static pressure measurements will indicate leaks in ductwork or ductwork filled with dust. Capture velocity at the hoods will indicate if the particle capture efficiency is changing.

Many steel plants will have daily maintenance records which indicate some of the less critical operating parameters of the control system. These data might include the voltage or amperage to the various fans, the alkalinity of the scrubber water, the water addition rate, voltage and amperage to the electrostatic precipitator, etc. Those plants which do not have periodic maintenance inspections are likely to have malfunctioning control equipment. Proper maintenance is an absolute requirement to reducing emissions to the atmosphere.

The inspector should not record visual emission observations which have been taken by plant owners or operators unless they have been certified by EPA or a state agency to make such opacity observations. The plant operator should record and report complaints and should indicate the probable cause of the problem. This data should be noted by the inspector.

4.3 REPORTING REQUIREMENTS

The EPA reporting requirements suggest that the owner or operator of a source, subject to continuous monitoring and recording requirements, should summarize such measurements monthly and should submit such summaries to the state on a quarterly or more frequent basis. As will be described later, the Federal requirement for new facilities to report startup, malfunction or shutdown is on a quarterly basis. Therefore, it seems logical and consistent to suggest the above records also be summarized on a monthly basis and submitted to the state quarterly.

40 CFR 60.7 contains notification and recordkeeping requirements for all facilities subject to NSPS. This section details the procedures for notifying the Administrator of construction, reconstruction, modification and startup and also requires that owners and operators maintain a file of all recorded information required by the regulations for at least two years following the dates of such measurements or reports.

Suggestions for formats and contents of recordkeeping tables are indicated in Tables 6.1, 6.2, 6.3, 6.4 and 6.5 at the end of section 6.0.

For further detail on monitoring, recordkeeping, and reporting requirements, please refer to:

- Federal Register, October 6, 1975 (14); and
- Guideline for the Selection and Operation of a Continuous Monitoring System for Continuous Emissions (16).

5.0 STARTUP, SHUTDOWN, AND MALFUNCTIONS

The Code of Federal Regulations, Title 40, Part 60, addresses the problem of startup, shutdown, and malfunctions. Section 60.11 (d) states, in part, "at all times, including periods of startup, shutdown, and malfunction, owners and operators shall, to the extent practicable, maintain and operate any affected facility including associated air pollution control equipment in a manner consistent with good air pollution control practice for minimizing emissions."

The above provisions presently apply to basic oxygen process furnaces. State agencies may well adopt similar requirements and, in fact, some states already require existing plant upset conditions to be reported. The principal difference, however, may be EPA's definition of malfunction which exclude several common causes of excessive emissions. The wording is as follows: "Malfunction means 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 malfunctions."

5.1 STARTUP

Startup operations are common practice occurring daily or even hourly, in the iron and steel industry. Since basic oxygen process furnaces are batch operations, startup of these furnaces poses no particular problem from the emission point of view. When a furnace is being heated up, only fuel is being burned.

Some irregularities in atmospheric emissions may occur during the startup of a new vessel. Most steel mills will have more than one BOPF as part of their total steel production capacity. Hence, one vessel may sit idle for several hours. When the scrap and hot metal are added to a cold furnace, higher emissions are likely on the first several heats of the new vessel. This is probably due to the additional oxygen required and additional blowing time required to get the steel to the proper temperature. Performance tests should not include any of these first several blows when a new vessel goes on-line.

Another startup condition that may affect air pollution emissions occurs when new refractory bricks have to be added to the vessel. This occurs about once a week. The bricks are replaced while the vessel is hot. Some additional particulate emissions are likely to occur as a result of the new refractory material and hence performance tests should not be made on the first heat after a relining has taken place.

5.2 SHUTDOWN

Shutdown of the furnace can be more of a problem than startup, however, since several tons of molten metal cannot be allowed to solidify in the furnace. In the event of a malfunction or failure in the control equipment (precipitator or scrubber), the furnace must be vented to the atmosphere for the remainder of the heat cycle or until the furnace can be prepared or stoked for holding. It is not desirable to allow the firebrick to become completely cold since damage to the firebrick may occur with frequent or extreme temperature changes.

5.3 MALFUNCTIONS

There are a few abnormal conditions relating to the process which can cause excessive emissions to the atmosphere. A marked increase in the oxygen blow rate may cause the vessel to froth and boil excessively. This additional splashing of the molten metal causes additional emissions to the atmosphere. It generally occurs during rapid production periods. This abnormal condition can be avoided by reducing the O_2 blow rate. The addition of magnesium to the molten iron is supposed to reduce the amount of froth and slag in the vessel. An insufficient amount of magnesium may cause the froth conditions to occur.

Upset conditions also may occur with the air pollution abatement equipment. A number of problems may arise with an electrostatic precipitator. The most serious with respect to air pollution emissions occurs when a section becomes dead and inoperative. Other precipitator deficiencies might include insufficient voltage, excessive spark rate, inadequate maintenance of the wrappers and corrosion of the ductwork in the precipitator lining.

One of the easiest parameters to use in assessing the performance of a scrubber is the pressure drop across the throat. For this industry, it has been shown that there exists a proportional relationship between scrubber pressure drop and scrubber efficiency. However, certain upset conditions or malfunctions can occur on scrubbers.

Any scaling or particulate build-up on the interior walls of the scrubber system that would cause an uneven distribution of the gas stream across the throat or on other critical portions of the scrubber may cause an overall decrease in collection efficiency of the unit. For those gas streams having high grain loadings, a build-up of mud will occasionally occur at the venturi throat. This mud build-up will cause a poor distribution of water at the throat and result in decreased efficiency. Some venturi systems have special gauges that monitor the pressure at each spray nozzle at the venturi throat.

Most venturi units will also have a mist eliminator to conserve on the water addition. The mist eliminator should be observed for mud build-up. Generally, the fans are located after the mist eliminator on the clean stream of exhaust gas prior to the stack. Because of the existence of water and some particulate matter in the exhaust stream, mud may also form on the blades of the fan causing excess vibration and imbalance. These conditions may ultimately cause the scrubber components to fail.

The task of minimizing emissions to the atmosphere is one of maintaining the air pollution abatement system. Those steel mills which utilize a routine maintenance system on electrostatic precipitators, scrubbers and the process equipment are certain to minimize emissions that would otherwise be caused by malfunctions or upsets. The plant philosophy of maintenance on production equipment should also apply to maintenance on air pollution control equipment. In the case of the basic oxygen process furnace, operators are usually forced to maintain their abatement equipment since it is a strategic part of the BOPF process.

Concentrating then on malfunctions that could cause excessive emissions, two types of malfunctions may be considered. The first category is made up of those conditions which would create excessive emissions into the workspace with subsequent discharge through the roof monitors to the atmosphere. Such a condition would very likely be manifested by insufficient draft on the collection hoods which could be due to:

(1) slippage on fan belts

(2) excessive pressure drop across the precipitator or scrubber

(3) fan rotating in the wrong direction

(4) leaking ductwork, access doors, explosion doors or discharge valve on air lock

(5) clogged ductwork or faulty damper

(6) duct size improper

(7) high temperatures and increased volumes of the exhaust gases

The second category of malfunctions could result from control equipment failures. The more important examples would include:

(1) motor failure

(2) fan unbalanced due to particulate build-up

(3) pump failure

(4) clogged or worn nozzles

(5) poor water distribution due to build-up of scale

(6) broken discharge wires

(7) excessive electrical arcing

(8) faulty rappers

(9) air circulation in the collection hopper

6.0 INSPECTION PROCEDURES

Generally speaking, emission rates from a BOPF installation will depend on the operating condition of the control device. Before an inspector visits a plant, he should obtain information, relative to the type of control equipment and process capacities utilized including feed rates and production rates from performance test and design data. This background data and performance test data will establish the operating history for this particular BOPF shop. Most steel plants will, in fact, have more than one vessel that is capable of producing steel and operating simultaneously. It is important that the inspector check the design data, plant capacity, and ductwork to assure that the abatement equipment is capable of handling one or more vessels running simultaneously. For a plant which has a number of vessels and several different control units, operators will frequently connect the ductwork so that vessels and control devices are interchangeable. This design feature is desirable from the production viewpoint but during high production periods with two or more vessels operating simultaneously, emission loadings and gas flow rates may exceed the capacity of the abatement unit.

Visual emission observations should be coordinated with roof observations and control room process sequencing. For example, two or three people on "walkie-talkie" radios may be required to identify the process and the capture efficiency of the hood at the time of visual emission observations. The visual emissions survey would be conducted to determine compliance with applicable SIP requirements since there are no visual emission limits under the NSPS requirements for BOPF's.

The inspector should observe at least one complete heat cycle from tap to tap during his visit. Certain types of operational data with respect to the process equipment and emission control equipment should be recorded on the inspector's worksheet. These include the operator's daily logs for each of the vessels, and a flow diagram of the plant's steelmaking process. Examples are shown at the end of Section 7.0. The inspector should examine previous records for other heats to diagnose whether current operations are normal or abnormal. Changes in the parameters mentioned above will alter emissions to the atmosphere.

The inspector should make a visual inspection from the floor of the BOPF shop of the adequacy of the collection system. For movable type hoods, it is necessary that the hood come in close proximity to the mouth of the vessel for effective capture of the particulate matter. Otherwise, dense smoke may emanate from the vessel and escape the hood, especially during the first part of the blow. The enforcement official should check for a build-up of slag on the lip of the vessel when the unit is turned down.

A check should be made to determine whether or not the inspiration flow rate is adequate during this inspection visit. If the plume escapes the hood it may be an indication that the collection system/fan is not operating properly or there is a leak in the ductwork.

Certain types of continuous recorded data will be available to ascertain the operating condition of the control equipment. It is not only important that the control equipment be operating correctly during the inspector's visit, but operating continuously. From any continuous recording charts, the inspector will be in a position to note factors like variations in pressure drop and opacity and ascertain whether or not this BOPF installation has been complying with emission regulations on a continuous basis. The inspector should also inquire about the maintenance program and the maintenance records for the air pollution control devices.

6.1 CONDUCT OF INSPECTION

Before an air pollution inspector visits a facility, it is necessary to establish the objectives of the inspection. In this regard, he may wish to check with his administrative, legal, or engineering advisors prior to the inspection since some or all of the following objectives may be important for a given plant inspection.

(1) Determine the scope of the facility's operation.

(2) Determine the applicability of standards.

(3) Inspect records and/or monitoring equipment.

(4) Evaluate visible emissions.

(5) Determine if a stack test is required.

(6) Conduct or observe stack tests or other field tests.

(7) Evaluate maintenance and operation of equipment.

(8) Establish compliance or non-compliance with compliance schedules.

(9) Investigate feasibility of various control methods.

(10) Investigate compliance with emergency episode plans.

Section 114(a)(2) of the Clean Air Act enables the Administrator or his authorized representative to enter a source so that EPA can do its own monitoring, sampling, inspecting, or copying of records. Such authority may be delegated to a state and be exercised by a state official.

In preparing for the inspection, the control official should:

(1) Review the literature on the subject industry's process descriptions, inspection points, and control equipment;

(2) Review the NEDS file or other plant file for details of processes and control equipment in use including plot plan;

(3) Review applicable standards (Federal, state and local);

(4) Review enforcement history on the plant;

- administrative and court actions
- compliance schedules
- monitoring and recordkeeping requirements
- previous inspections
- section 115 abatement actions
- waivers, notifications, quarterly reports, registration (NSPS and NESHAPS)

(5) Finalize objectives;

(6) If appropriate provide advance notice;

(7) Obtain credentials and business cards (EPA has a procedure regarding the issuance and control of credentials);

(8) If desired, obtain for handout a supply of applicable statutes and regulatory authority as well as EPA or state literature explaining the enforcement program;

(9) Obtain or develop a supply of inspection checklists;

(10) Obtain personal safety equipment. (A source owner or operator has no responsibility to supply EPA inspectors with safety equipment.)

- fire retardant coveralls
- hard hat
- safety glasses or goggles
- steel-toed shoes
- respirator
- gloves
- overalls

(11) Obtain necessary inspection equipment

- tape measure
- flashlight
- thermometer and gauge
- manometer (flex-tube)
- inclined manometer
- RPM indicator
- velometer
- camera
- Fyrite combustion analyzer- O_2, CO, CO_2
- smoke spot analyzer

6.2 INSPECTION CHECKLIST

After preparing for the inspection by reading appropriate information and obtaining necessary equipment, the control official is ready for the actual site visit. Before entering the plant property it is desirable to observe the stacks and roof monitors for evidence of visible emissions. If a plume is consistently visible, opacity observations should be recorded for possible violation. Time should be allowed for such observations prior to the appointment.

At the plant entrance, present credentials and request to see the most senior or responsible official of the company. Generally this person will be the plant manager. The inspector should not sign the waiver forms or "visitor releases." The inspector has specific legal authority (Federal or state) for right of entry and signing such forms may adversely affect his Federal or state insurance or survivors benefits. If a source persists in its refusal, the matter should be carried to court. If a source simply refuses right of entry, a request must be made through a U.S. attorney for a search warrant.

Upon meeting the responsible plant official, the inspector may be questioned on the following items and should be prepared to discuss:

(1) The purpose of the inspection (NSPS, SIP, NESHAPS);

(2) The authority for the inspection (113, 114, State law, etc.);

(3) The agency's organization and responsibilities;

(4) Recent history of legislative and enforcement activity affecting the subject industry and specific plant;

(5) The scope, timing, and organization of the inspection;

(6) Information and records to be examined (self-incrimination - see Appendix C);

(7) The treatment of confidential data (trade secrets - see Appendix C);

(8) Possible measurements to be made;

(9) Possible follow-up activity regarding:

- future inspections
- section 113 or 114 letter
- stack tests
- notice of violation.

After the preliminaries are completed, the inspector should request the name, title and address of the most appropriate company officer for official correspondence and for contact on future inspections.

Next, he should request a brief summary of the plant's production facilities and air pollution control equipment. This information will substantiate the NEDS or other emission source data that the agency has on file or will provide the basis for updating or correcting such files.

The company official should be asked to indicate which processes, unit operations, furnaces, and control equipment are (at the time of the discussion) operating at or near normal operating conditions. Likewise, the company official should be asked to indicate which facilities are not operating at or near normal operating conditions and to indicate the reasons and the timing (date and hour) for shutdown or malfunctioning equipment. The schedule for returning shutdown equipment to operation should be indicated. The malfunctioning equipment should be shutdown if such malfunctioning adversely affects emission rates to the atmosphere and the schedule for shutdown and correction should be indicated.

Next, the inspector should request a quick rather cursory tour of the plant facilities and the company official should point out all of the sources and control equipment indicated earlier. Access to the roof and to the stacks should be requested and visual observations should be made of hood capture efficiencies, stack effluents, sampling ports and platforms, ductwork conditions, and general housekeeping in and around the plant. However, the inspector should be aware that the upper levels and roof area of the BOPF shop itself are extremely hazardous during operation and access is not recommended. Evidence of dust or fume accumulation on the plant roof or at the stack exit should be noted where safe access can be obtained. During this tour the inspector should note whether the process, furnace, etc. is running and whether its operation warrants more detailed analysis.

After getting acquainted with the plant and its facilities, the inspector should request that the company official provide information from his records that will allow the inspector to complete the process, control equipment and malfunction record forms which are appended. Records for the complete calendar month prior to the visit will generally suffice to give a baseline of the plant's operations. With such information, comparisons can be made with future operations, with past performance test and design operating conditions, and with operations at the time of the current inspection. In the event the company identified certain data as confidential, a company official must make a request for such confidentiality in writing to EPA.

Next, the control official should request the company official's assistance in verifying the real-time operating conditions and actual production rate of each process, furnace, etc. in the plant. This plant inspection may take several hours and the records or data which the official cites--weights, fuel flow measurements, temperatures, etc.--should be seen and verified by the air pollution inspector. After verifying that certain equipment is operating, the inspector should be prepared to take his own data on fan speeds, gas velocity and duct flow rates, static pressure, pressure drops, hood capture velocities, and temperatures (both dry bulb and wet bulb). On equipment that is not operating, especially control equipment, the opportunity should be taken to open access doors to check ductwork, clean-air plenum, valves and dampers, fan drive belts, collection hoppers, etc. The inspector should take note of those conditions given in section 5.0 which can lead to malfunctions and check the equipment accordingly.

6.3 INSPECTION FOLLOW-UP PROCEDURES

Upon completion of the inspection, the inspector should sign and date all notes and inspection forms making certain that all blanks are completed. He should advise the company officials that he will review his findings with his legal and technical advisors prior to making recommendations for any necessary action. The inspector should not advise the company official of specific violations. The conclusion of all inspections will be: (1) affected facilities are in violation of standards; (2) affected facilities are in compliance with standards; or (3) affected facilities are not being operated or maintained precisely in accordance with the performance tests but violations are not clearly evident. Where operating conditions have a high probability of producing greater emissions than those recorded during the performance tests, a new performance test may be required of the source by the Administrator Also, poor maintenance and housekeeping is a violation of NSPS regulation 60.11(d).

In the first case for basic oxygen process furnaces subject to the NSPS, the only violations which could be cited at the present time under Section 113 are particulate matter or failure to record or report malfunctions.

In the second case, the plant will be found to be operating and maintaining its facilities in a manner consistent with good air pollution control practice for minimizing emissions. Also the affected facilities will be found to be operating essentially at the production rates and under the conditions recorded at the time of the performance tests.

In the third case, which will be the most common and the most difficult, inspections will be concluded with a need for recommendations to improve specific operating or maintenance procedures so as to be consistent with the performance test conditions and with good air pollution control practice for minimizing emissions. If such recommendations are not followed and the inspector feels that emissions may be excessive, a performance test would be required to substantiate or refute compliance with the regulations. On the matter of what conditions constitute a significant deviation so as to require a new performance test, the inspector should not make a decision in the field. Instead, he should record field data from which technical and legal advisors can draw such a conclusion.

Regardless of the findings, the designated company officer should be notified in writing of the inspection results and any required action on the company's part should be spelled out in detail with a time schedule to bring the facilities back into compliance. Section 113 of the Act should be cited. At the conclusion of the designated time period for compliance, a follow-up inspection should be made to verify conformance with the recommendations and applicable standards.

For further information on inspection procedures refer to:

- Field Surveillance and Enforcement Guide for Primary Metallurgical Industries (15)

- Workshop on Stationary Source Inspections (21)

- Air Pollution Control Field Operations Manual (19)

- S12. - General Policy on the Use of Section 114 Authority for Enforcement Purposes (Appendix C)

- Emission Testing Compliance Manual (11)

Table 6.1 BASIC OXYGEN PROCESS FURNACE INSPECTORS WORKSHEET

Part I - Process Data

Company	FROM: TO: Dates Covered
Street Address	Furnace - Company Designation
City State	Furnace Identification No. or NEDS No.
Official Completing Form	Furnace Type
Title of Official	Furnace Rated Capacity

Heat Number	HEAT PERIOD Charge m	Refine m	Pour m	Total m	RAW MATERIALS Pig Iron tons	Iron Scrap tons	Oxygen ft^3	PRODUCTION SPECIFICATION - PER CENT Fe	C	Other

date Inspector

Table 6.2 BASIC OXYGEN PROCESS FURNACE INSPECTORS WORKSHEET

Part II - Control Equipment Data

______________________ Company	FROM: __________ TO: __________ Dates Covered
______________________ Street Address	______________________ Control Equipment Co. Designation
______________________ City State	______________________ State Permit Number or NEDS Number
______________________ Official Providing Information	______________________ Control Equipment Type
______________________ Title of Official	

Process equipment ducted to this control equipment ______________________

____

____

Quantity of dust collected	______ tons	Static pressure in collection system	
Gas flow rate @ collector inlet	______ acfm	stack	______ "H_2O
Gas flow rate @ collector outlet	______ acfm	before fan	______ "H_2O
Temperature @ collector inlet	______ ^oF	collector outlet	______ "H_2O
Temperature @ collector outlet	______ ^oF	collector inlet	______ "H_2O
Fan Speed	______ rpm	before coolers	______ "H_2O
Capture velocity of hood over furnace	______ fpm	duct after hood	______ "H_2O
Precipitator		Scrubber	
spark rate	______ spm	pressure drop	______ "H_2O
primary voltage	______ volts	water flow rate	______ gpm
primary amps	______ amps		

Remarks concerning inspections, maintenance and repairs ______________________

____

____

____

______________ date ______________ Inspector

Table 6.3 BASIC OXYGEN PROCESS FURNACE INSPECTORS WORKSHEET
Part III - Startup, Shutdown, and Malfunction

FROM: ____________ TO: ____________
Dates Covered

____
Company

____
Street Address

____
City State

____
Official Providing Information

____
Title of Official

Excess emissions occurred

Began ______________________________
date time

Ended ______________________________
date time

Were excess emissions due to startup, shutdown, or malfunction ______________________________

Describe the magnitude of the excess emissions ______________________________

Detailed explanation of reasons for excess emissions ______________________________

Corrective action taken to halt excess emissions ______________________________

Preventative measures adopted to prevent recurrence ______________________________

Further comments ______________________________

______________ ______________
date Inspector

Table 6.4 BASIC OXYGEN PROCESS FURNACE INSPECTORS WORKSHEET
Part IV - General Observations

____
Company

FROM: ____________ TO: ____________
Dates Covered

____
Street Address

____
City State

____
Official Providing Information

____
Tital of Official

Process

Charging procedures - weights, frequency ______________________________

Charge quality - percent scrap and percent pig iron ______________________________

Capture efficiency of hoods ______________________________

Control Equipment

Cleaning cycle ______________________________

Structural integrity ______________________________

Ductwork condition ______________________________

Testing facilities ______________________________

Emissions

Visible emissions from stack Method 9 ______________________________

Visible emissions around hoods Method 9 ______________________________

______________________________ ______________________________
Date Inspector

7.0 PERFORMANCE TEST

The Code of Federal Regulations, Title 40, Part 60 provides in Section 60.8 for performance tests of new basic oxygen process furnaces. The test calls for three separate runs using standard EPA test methods and procedures. The Administrator, however, can modify the testing requirement; he can even waive it. If tests are to be conducted, the owner or operator must give EPA 30 days notice. EPA must then specify the operating conditions of the tested furnace. At the time of the test, the inspector should be present to observe process and control device operation so that subsequent inspections can be correlated with the performance test "baseline" operating conditions. Also at the time of the tests, the inspector should check certain of the source testing procedures to ensure that the tests are conducted properly. Each of these three requirements is considered separately in the ensuing discussion.

7.1 PROCESS OPERATING CONDITIONS

The purpose of the performance test is to determine whether the emission standards will be met when the furnace is operating at normally encountered conditions that create the maximum emission rate. The operating conditions that should be specified for the tests are as follows:

(1) The production rate should be the maximum rated capacity of the furnace;

(2) The period of the heat should be the minimum possible to achieve the specification of the melt;

(3) The specification of the steel to be produced should be typical of the product produced by the affected facility to be tested;

(4) The consumption rate for oxygen should be the maximum rate anticipated;

(5) The fuel consumption rate, if any, should be the maximum rate anticipated;

(6) The flux addition rate should provide a slag and flux cover depth typical of the operation to be tested; and,

(7) The pouring temperature should be the maximum anticipated for the steel being produced.

7.2 PROCESS OBSERVATIONS

There are several subjective type observations which need to be made during the performance test. For the closed or movable hood systems, it is important that the hood come in very close proximity to the converter mouth. Sometimes a build-up of slag on the converter lip may prevent the hood from fitting snugly over the vessel. During the performance tests, an observation and description should be made of the movable hood and its relationship to the amount of slag on the lip and how well it fits over the vessel.

Another observation that can be made which will affect air pollution emissions and establish the manner in which steel is produced at this shop is the amount of slag or froth which overflows during the oxygen-blowing period. If the slag "boils over" and is emitted from the mouth of the converter during the oxygen blow period, it may indicate an abnormal heat or one made in haste. Data taken during the performance test should also indicate the number of reblows that have taken place for each heat.

Changes in the above mentioned data taken during the performance tests are likely to change air pollution emissions from the BOPF. Increase in particulate emissions from the BOPF will likely result from an increase in the amount of hot metal, scrap, spark rate, primary voltage, and the temperature at the inlet to the abatement device. An increase in air pollution emissions also will result from a decrease in the oxygen-blowing period, cycle time, pressure drop, and water flow rate. The converse of these situations is also true.

The total charge or the total production rate will affect emissions. Since most of the emissions are due to oxidation, a furnace half full will have only one-half the mass rate of emission of iron oxide. Yet the oxygen consumption rate and certainly the air delivered to the precipitators and scrubbers will be nearly the same in both cases; thus, the grain loading will be reduced if the production is reduced.

The duration of the heat is important in that the quantity of impurities to be removed from scrap remains constant regardless of the duration of the heat. There is effective dilution and lowering of the grain loading with longer than normal refining times.

The approximate iron and steel content of the scrap which is charged should be noted. If the charge is high in impurities and the final product is very low in impurities, then more refining will be necessary to remove impurities and most of this material will go to the control equipment.

The oxygen consumption rate relates to the speed with which the impurities in the molten metal are removed. If the rates are low and the time longer, emission rates will be less than if the rates are high and the time shorter. If the source test is conducted for only one hour or so, care should be exercised to include representative oxygen blowing conditions.

The thickness of the slag cover may be important since the slag cover reduces the loss of steel due to oxidation.

If the pouring temperature is higher than necessary, the fume emission will be increased.

7.3 EMISSION TEST OBSERVATIONS

Certain operational parameters should be recorded during a performance test that are critical for future plant visits by the federal enforcement official to establish what changes in the operating parameters have taken place that would affect the pollution emissions to the atmosphere.

The standards of performance for the basic oxygen process furnace are applicable only to a certain portion of the heat. 40 FR 60.144(b) requires that the Method 5 tests be conducted for an integral number of cycles; a cycle shall start at the beginning of either the scrap preheat or the oxygen blow and shall terminate immediately prior to tapping. Sampling shall be conducted for a minimum total duration of 60 minutes with a sampling rate of at least 0.9 dscm/hr (0.53 dscf/min).

Emission tests and opacity determinations should be conducted by qualified emission testing personnel. The inspector is responsible for ensuring that all pertinent data are collected, that the field procedures and equipment meets CFR, and that the BOPF is run at representative performance during all sampling runs. A qualified technician or engineer reads visible emissions during the three particulate runs. The approved visible emission observation data form appears in Appendix B.

The inspector's degree of surveillance of the stack sampling team depends on the confidence of the inspector and qualifications of the test personnel. Even if the inspector has complete trust in the sampling crew, the following tasks should always be performed:

(1) Record duct dimensions (both inside and outside) and locations of sample ports.

(2) Check the number of ports at the sampling site and examine the ducting for the nearest upstream and downstream obstructions. Ask the crew leader how many total points will be traversed and check with Figure 1.1 in 40 CFR 60 (Method 1) to determine whether the stream will be properly sampled.

(3) Note whether the crew runs a preliminary traverse, and if so, inquire what nozzle diameter is selected. Nozzle diameter should be measured with a micrometer to verify indicated size. (Isokinetic sampling is a function of nozzle size.)

(4) Check to ensure that the moisture content of the gas stream is determined by Method 4 or an equivalent method such as drying tubes or volumetric condensers; assumption of the moisture content is not allowed. Note, however, that EPA has proposed a method for the estimation of the moisture content for the purpose of determining isokinetic sampling rate settings. The proposed method appears at 41 FR 23060 (June 8, 1976).

(5) Observe the leak test of the sampling train. The allowable leak rate is given in Method 5. Leakage results in lower concentrations than are actually present. Be next to the dry gas meter during the leak check, note whether the meter hand is moving. (The more the hand is moving, the greater the leakage.) Leak checks must be made if the train is disassembled during the run to change a filter or to replace any component.

(6) Record dry gas meter reading before and after test.

(7) Record average velocity head and temperatures in duct during test.

(8) If impingers are used during test, observe whether they are bubbling. If they are not, the sampling train is either plugged or disconnected from the pump.

(9) Check the cleaning procedure for the front half of the train. Careless removal of filters or cleaning of probes will result in lower calculated emissions. Look for broken glass from probes or connectors. Test is void if glass probe is broken during test. If glass connectors are broken in transport from sampling site to cleanup area, test is still valid. Be sure identification labels are properly attached to collection

containers. The probe should be brushed and rinsed with acetone thoroughly to remove all particulates. The probe should be visually inspected after cleaning to ascertain that all particulates have been removed.

(10) Observe gas analysis procedure for determining CO_2. Technician should take at least three samples before averaging readings. Variations greater than 0.5 per cent (grab sample) or 0.2 per cent (integrated sample) indicate gas mixture was not thoroughly bubbled in reagents. Ask technician or crew leader when new reagents were added to apparatus.

(11) Check per cent isokinetic.

(12) Inquire about the calibration history of the flow volume recorder. The flow measuring device is required to maintain an accurate of $\pm$ 5 per cent over its operating range.

7.4 PERFORMANCE TEST DATA

The inspector must observe furnace operation and emission tests simultaneously to ensure that valid data are used in determining plant performance. The performance test checklist shown in Table 7.1 is based upon the observations described in Sections 7.1, 7.2 and 7.3. Suggested contents for stack test reports are given in Appendix E.

The reasons for having the inspector observe the test and complete the inspection sheet are twofold. First, furnace and control device parameters will serve as guidelines for future NSPS recordkeeping requirements; and second, the inspector's observation of a few major parameters ensures that the tests were properly conducted.

The emission-testing firm is required to submit test reports to the facility and the control agency. Results from the testing firm must be carefully checked and compared with data from the inspector's form.

Table 7.1

NSPS INSPECTION CHECKLIST FOR BASIC OXYGEN PROCESS FURNACE DURING PERFORMANCE TEST

Facility Name ______________________________

Facility Address ______________________________

Name of Plant Contact ______________________________

Source Code Number ______________________________

Unit Identification (To be tested) ______________________________

Design Input Capacity ____________ tons/day

Initial Start-up Date ______________________________

Test Date ______________________________

A. FACILITY DATA

Type	Furnace		No. of Furnaces ________ Specify ____________
Charging Method	Batch	Continuous	
Control Devices	Precipitator Scrubber Other		Specify Type ________ Specify Type ________

Operating Schedule ____hrs/day ____days/wk ____wks/yr

B. OPERATING PARAMETERS

Data to Obtain During Performance Test[a]

Parameter
Charge Capacity
Charge Rate
Period of Heat
Oxygen Rate
Pouring Temperature

[a] Data should be recorded for every heat.

Table 7.1 (continued). NSPS INSPECTION CHECKLIST FOR BASIC OXYGEN PROCESS FURNACE DURING PERFORMANCE TEST

C. PRETEST DATA (OBTAIN FROM TEST TEAM FIELD LEADER)

Test Company ____________________

Field Leader ____________________

Duct Dimensions ________in. x ________in.; Area ________ft^2

Nearest Upstream Obstruction ____________ft

Nearest Downstream Obstruction ____________ft

No. of Sampling Ports ____________

No. of Sampling Points ____________

No. of Sampling Points Required From 40 CFR 60 ____________

D. PARTICULATE PERFORMANCE TEST

Test No. ________ Start Time ________ Finish Time ________

	Yes	No
Preliminary Traverse Run (Method 1) Chosen Nozzle Diameter ________in.		
Train Leak Check		
Opacity Readings Taken		
Moisture Determination (Method 4) Per cent Moisture ________ ml Collected/Gas Volume ________ml ________ft^3 (or wet/dry bulb readings)		

Combustion Gas Analyzer O_2 ________%

CO_2 ________%

Dry Gas Meter Reading Before Test ________ft^3 at ________(time)

Dry Gas Meter Reading After Test ________ft^3 at ________(time)

Volume Sampled ____________ft^3

Table 7.1 (continued). NSPS INSPECTION CHECKLIST FOR BASIC OXYGEN FURNACES DURING PERFORMANCE TEST

D. PARTICULATE PERFORMANCE TEST (continued)

Test Duration ______________ minutes

Average Meter Orifice Pressure Drop __________ inches

Average Duct Temperature _________ ^oF

Velocity Head at Sampling Point _____________ inches H_2O

Meter H _____________

Repetition Start Time _____________

Repetition Finish Time _____________

E. CLEAN-UP PROCEDURE

Filter Condition	Dry		Wet
Probe Status	Unbroken		Broken
Glass Connectors	Unbroken		Broken
Clean-up Sample Spillage	None	Slight	Major
Sample Bottle Identification	Yes		No
Acetone Blank Taken	Yes		No

8.0 REFERENCES

(1) "A Manual of Electrostatic Precipitator Technology, Part I." National Air Pollution Control Administration, Durham, N.C. (1970)

(2) "A Systems Study of the Integrated Iron and Steel Industry." National Air Pollution Control Administration, Durham, N.C. (1970)

(3) "Air Pollution Aspects of the Iron and Steel Industry." U.S. Department of Health, Education and Welfare, Cincinnati, Ohio (1963)

(4) "Air Pollution Engineering Manual." U.S. Department of Health, Education and Welfare, Cincinnati, Ohio (1967)

(5) "Air Pollution Manual, Part II, Control Equipment." American Industrial Hygiene Association, Detroit, Michigan (1968)

(6) Allen, Glen L. "Control of Metallurgical and Mineral Dusts and Fumes in Los Angeles County, California," U.S. Department of the Interior, Washington, D.C. (April 1952)

(7) Background Information for Proposed New Source Performance Standards; Vol. 1, Main Text. Environmental Protection Agency, Research Triangle Park, N.C. (June 1973)

(8) Calvert, S. "Systems Study of Scrubbers," Environmental Protection Agency, Research Triangle Park, N.C. (1972)

(9) Federal Register, Vol. 40, No. 242. General Services Administration, Washington, D.C. (December 16, 1975)

(10) "Control Techniques for Particulate Air Pollutants," U.S. Department of Health, Education and Welfare, Washington, D.C. (January 1969)

(11) Emission Testing Compliance Manual, EPA 68-02-0237. Environmental Protection Agency, Washington, D.C. (1974)

(12) Federal Register, Vol. 39, No. 177. General Services Administration, Washington, D.C. (September 11, 1974)

(13) Federal Register, Vol. 39, No. 200. General Services Administration, Washington, D.C. (October 15, 1974)

(14) Federal Register, Vol. 40, No. 194. General Services Administration, Washington, D.C. (October 6, 1975)

(15) Field Surveillance and Enforcement Guide for Primary Metallurgical Industries. Engineering-Science, Inc., Washington, D.C. (December 1973)

(16) Guideline for the Selection and Operation of a Continuous Monitoring System for Continuous Emissions. Division of Stationary Source Enforcement, Environmental Protection Agency, Washington, D.C. (1974)

(17) Hayward, C.R., "An Outline of Metallurgical Practice," D. Van Nostrand Company, N.Y. (1952)

(18) Stern, A.C., "Air Pollution, Volume III, Sources of Air Pollution and Their Control," Academic Press, N.Y. (1968)

(19) Weisburd, Melvin I., "Air Pollution Control Field Operations Manual," U.S. Department of Health, Education and Welfare, Washington, D.C. (December 1962)

(20) "Wet Scrubber System Study." Environmental Protection Agency, Durham, N.C. (1972)

(21) Workshop on Stationary Source Enforcement, Engineering-Science, Inc., Washington, D.C. (December 1974)

(22) Zavier, J.A. "Survey of Air Pollution from the Kaiser Steel Plant," State of California Air Resources Board, Sacramento, California (1971)

(23) Code of Federal Regulations, Title 40, Part 51 Revised as of July 1, 1976, General Services Administration, Washington, D.C. (1976)

APPENDIX A

STANDARDS OF PERFORMANCE FOR NEW STATIONARY SOURCES

Chapter 1 - Environmental Protection Agency

SUBCHAPTER C - AIR PROGRAMS

PART 60 - STANDARDS OF PERFORMANCE FOR NEW STATIONARY SOURCES

Subpart N - Standards of performance for Iron and Steel Plants

§60.140 Applicability and designation of affected facility.

The affected facility to which the provisions of this subpart apply is each basic oxygen process furnace.

§60.141 Definitions.

As used in this subpart, all terms not defined herein shall have the meaning given them in the Act and in subpart A of this part.

(a) "Basic oxygen process furnace" (BOPF) means any furnace producing steel by charging scrap steel, hot metal, and flux materials into a vessel and introducing a high volume of an oxygen-rich gas.

(b) "Steel production cycle" means the operations required to produce each batch of steel and includes the following major functions: scrap charging, preheating (when used), hot metal charging, primary oxygen blowing, additional oxygen blowing (when used), and tapping.

§60.142 Standard for particulate matter.

(a) On and after the date on which the performance test required to be conducted by §60.8 is completed, no owner or operator subject to the provisions of this subpart shall discharge or cause the discharge into the atmosphere from any affected facility any gases which:

(1) contain particulate matter in excess of 50 mg/dscm (0.022 gr/dscf).

(2) (Reserved.)

§60.143 (Reserved)

§60.144 Test methods and procedures.

(a) The reference methods appended to this part, except as provided for in §60.8(b), shall be used to determine compliance with the standards prescribed in §60.142 as follows:

(1) Method 5 for concentration of particulate matter and associated moisture content,

(2) Method 1 for sample and velocity traverses,

(3) Method 2 for volumetric flow rate, and

(4) Method 3 for gas analysis.

(b) For Method 5, the sampling for each run shall continue for an integral number of cycles with total duration of at least 60 minutes. The sampling rate shall be at least 0.9 dscm/hr (0.53 dscf/min) except that shorter sampling times, when necessitated by process variables or other factors, may be approved by the Administrator. A cycle shall start at the beginning of either the scrap preheat or the oxygen blow and shall terminate immediately prior to tapping.

APPENDIX B

METHOD 9 - VISUAL DETERMINATION OF THE OPACITY OF EMISSIONS FOR STATIONARY SOURCES

METHOD 9—VISUAL DETERMINATION OF THE OPACITY OF EMISSIONS FROM STATIONARY SOURCES

Many stationary sources discharge visible emissions into the atmosphere; these emissions are usually in the shape of a plume. This method involves the determination of plume opacity by qualified observers. The method includes procedures for the training and certification of observers, and procedures to be used in the field for determination of plume opacity. The appearance of a plume as viewed by an observer depends upon a number of variables, some of which may be controllable and some of which may not be controllable in the field. Variables which can be controlled to an extent to which they no longer exert a significant influence upon plume appearance include: Angle of the observer with respect to the plume; angle of the observer with respect to the sun; point of observation of attached and detached steam plume; and angle of the observer with respect to a plume emitted from a rectangular stack with a large length to width ratio. The method includes specific criteria applicable to these variables.

Other variables which may not be controllable in the field are luminescence and color contrast between the plume and the background against which the plume is viewed. These variables exert an influence upon the appearance of a plume as viewed by an observer, and can affect the ability of the observer to accurately assign opacity values to the observed plume. Studies of the theory of plume opacity and field studies have demonstrated that a plume is most visible and presents the greatest apparent opacity when viewed against a contrasting background. It follows from this, and is confirmed by field trials, that the opacity of a plume, viewed under conditions where a contrasting background is present can be assigned with the greatest degree of accuracy. However, the potential for a positive error is also the greatest when a plume is viewed under such contrasting conditions. Under conditions presenting a less contrasting background, the apparent opacity of a plume is less and approaches zero as the color and luminescence contrast decrease toward zero. As a result, significant negative bias and negative errors can be made when a plume is viewed under less contrasting conditions. A negative bias decreases rather than increases the possibility that a plant operator will be cited for a violation of opacity standards due to observer error.

Studies have been undertaken to determine the magnitude of positive errors which can be made by qualified observers while reading plumes under contrasting conditions and using the procedures set forth in this method. The results of these studies (field trials) which involve a total of 769 sets of 25 readings each are as follows:

(1) For black plumes (133 sets at a smoke generator), 100 percent of the sets were read with a positive error[1] of less than 7.5 percent opacity; 99 percent were read with a positive error of less than 5 percent opacity.

(2) For white plumes (170 sets at a smoke generator, 168 sets at a coal-fired power plant, 298 sets at a sulfuric acid plant), 99 percent of the sets were read with a positive error of less than 7.5 percent opacity; 95 percent were read with a positive error of less than 5 percent opacity.

The positive observational error associated with an average of twenty-five readings is therefore established. The accuracy of the method must be taken into account when determining possible violations of applicable opacity standards.

1. *Principle and applicability.*

1.1 Principle. The opacity of emissions from stationary sources is determined visually by a qualified observer.

1.2 Applicability. This method is applicable for the determination of the opacity of emissions from stationary sources pursuant to § 60.11(b) and for qualifying observers for visually determining opacity of emissions.

2. *Procedures.* The observer qualified in accordance with paragraph 3 of this method shall use the following procedures for visually determining the opacity of emissions:

2.1 Position. The qualified observer shall stand at a distance sufficient to provide a clear view of the emissions with the sun oriented in the 140° sector to his back. Consistent with maintaining the above requirement, the observer shall, as much as possible, make his observations from a position such that his line of vision is approximately perpendicular to the plume direction, and when observing opacity of emissions from rectangular outlets (e.g. roof monitors, open baghouses, noncircular stacks), approximately perpendicular to the longer axis of the outlet. The observer's line of sight should not include more than one plume at a time when multiple stacks are involved, and in any case the observer should make his observations with his line of sight perpendicular to the longer axis of such a set of multiple stacks (e.g. stub stacks on baghouses).

2.2 Field records. The observer shall record the name of the plant, emission location, type facility, observer's name and affiliation, and the date on a field data sheet (Figure 9–1). The time, estimated distance to the emission location, approximate wind direction, estimated wind speed, description of the sky condition (presence and color of clouds), and plume background are recorded

[1] For a set, positive error=average opacity determined by observers' 25 observations—average opacity determined from transmissometer's 25 recordings.

on a field data sheet at the time opacity readings are initiated and completed.

2.3 Observations. Opacity observations shall be made at the point of greatest opacity in that portion of the plume where condensed water vapor is not present. The observer shall not look continuously at the plume, but instead shall observe the plume momentarily at 15-second intervals.

2.3.1 Attached steam plumes. When condensed water vapor is present within the plume as it emerges from the emission outlet, opacity observations shall be made beyond the point in the plume at which condensed water vapor is no longer visible. The observer shall record the approximate distance from the emission outlet to the point in the plume at which the observations are made.

2.3.2 Detached steam plume. When water vapor in the plume condenses and becomes visible at a distinct distance from the emission outlet, the opacity of emissions should be evaluated at the emission outlet prior to the condensation of water vapor and the formation of the steam plume.

2.4 Recording observations. Opacity observations shall be recorded to the nearest 5 percent at 15-second intervals on an observational record sheet. (See Figure 9-2 for an example.) A minimum of 24 observations shall be recorded. Each momentary observation recorded shall be deemed to represent the average opacity of emissions for a 15-second period.

2.5 Data Reduction. Opacity shall be determined as an average of 24 consecutive observations recorded at 15-second intervals. Divide the observations recorded on the record sheet into sets of 24 consecutive observations. A set is composed of any 24 consecutive observations. Sets need not be consecutive in time and in no case shall two sets overlap. For each set of 24 observations, calculate the average by summing the opacity of the 24 observations and dividing this sum by 24. If an applicable standard specifies an averaging time requiring more than 24 observations, calculate the average for all observations made during the specified time period. Record the average opacity on a record sheet. (See Figure 9-1 for an example.)

3. *Qualifications and testing.*

3.1 Certification requirements. To receive certification as a qualified observer, a candidate must be tested and demonstrate the ability to assign opacity readings in 5 percent increments to 25 different black plumes and 25 different white plumes, with an error not to exceed 15 percent opacity on any one reading and an average error not to exceed 7.5 percent opacity in each category. Candidates shall be tested according to the procedures described in paragraph 3.2. Smoke generators used pursuant to paragraph 3.2 shall be equipped with a smoke meter which meets the requirements of paragraph 3.3.

The certification shall be valid for a period of 6 months, at which time the qualification procedure must be repeated by any observer in order to retain certification.

3.2 Certification procedure. The certification test consists of showing the candidate a complete run of 50 plumes—25 black plumes and 25 white plumes—generated by a smoke generator. Plumes within each set of 25 black and 25 white runs shall be presented in random order. The candidate assigns an opacity value to each plume and records his observation on a suitable form. At the completion of each run of 50 readings, the score of the candidate is determined. If a candidate fails to qualify, the complete run of 50 readings must be repeated in any retest. The smoke test may be administered as part of a smoke school or training program, and may be preceded by training or familiarization runs of the smoke generator during which candidates are shown black and white plumes of known opacity.

3.3 Smoke generator specifications. Any smoke generator used for the purposes of paragraph 3.2 shall be equipped with a smoke meter installed to measure opacity across the diameter of the smoke generator stack. The smoke meter output shall display in-stack opacity based upon a pathlength equal to the stack exit diameter, on a full 0 to 100 percent chart recorder scale. The smoke meet the specifications shown in Table 9-1. The smoke meter shall be calibrated as prescribed in paragraph 3.3.1 prior to the conduct of each smoke reading test. At the completion of each test, the zero and span drift shall be checked and if the drift exceeds ±1 percent opacity, the condition shall be corrected prior to conducting any subsequent test runs. The smoke meter shall be demonstrated, at the time of installation, to meet the specifications listed in Table 9-1. This demonstration shall be repeated following any subsequent repair or replacement of the photocell or associated electronic circuitry including the chart recorder or output meter, or every 6 months, whichever occurs first.

TABLE 9-1—SMOKE METER DESIGN AND PERFORMANCE SPECIFICATIONS

Parameter:	*Specification*
a. Light source	Incandescent lamp operated at nominal rated voltage.
b. Spectral response of photocell.	Photopic (daylight spectral response of the human eye—reference 4.3).
c. Angle of view	15° maximum total angle.
d. Angle of projection.	15° maximum total angle.
e. Calibration error.	±3% opacity, maximum.
f. Zero and span drift.	±1% opacity, 30 minutes.
g. Response time	≤5 seconds.

3.3.1 Calibration. The smoke meter is calibrated after allowing a minimum of 30 minutes warmup by alternately producing simulated opacity of 0 percent and 100 percent. When stable response at 0 percent or 100 percent is noted, the smoke meter is adjusted to produce an output of 0 percent or 100 percent, as appropriate. This calibration shall be repeated until stable 0 percent and 100 percent readings are produced without adjustment. Simulated 0 percent and 100 percent opacity values may be produced by alternately switching the power to the light source on and off while the smoke generator is not producing smoke.

3.3.2 Smoke meter evaluation. The smoke meter design and performance are to be evaluated as follows:

3.3.2.1 Light source. Verify from manufacturer's data and from voltage measurements made at the lamp, as installed, that the lamp is operated within ±5 percent of the nominal rated voltage.

3.3.2.2 Spectral response of photocell. Verify from manufacturer's data that the photocell has a photopic response; i.e., the spectral sensitivity of the cell shall closely approximate the standard spectral-luminosity curve for photopic vision which is referenced in (b) of Table 9-1.

3.3.2.3 Angle of view. Check construction geometry to ensure that the total angle of view of the smoke plume, as seen by the photocell, does not exceed 15°. The total angle of view may be calculated from: $\theta=2 \tan^{-1} d/2L$, where θ=total angle of view; d=the sum of the photocell diameter+the diameter of the limiting aperture; and L=the distance from the photocell to the limiting aperture. The limiting aperture is the point in the path between the photocell and the smoke plume where the angle of view is most restricted. In smoke generator smoke meters this is normally an orifice plate.

3.3.2.4 Angle of projection. Check construction geometry to ensure that the total angle of projection of the lamp on the smoke plume does not exceed 15°. The total angle of projection may be calculated from: $\theta=2 \tan^{-1} d/2L$, where θ= total angle of projection; d= the sum of the length of the lamp filament + the diameter of the limiting aperture; and L= the distance from the lamp to the limiting aperture.

3.3.2.5 Calibration error. Using neutral-density filters of known opacity, check the error between the actual response and the theoretical linear response of the smoke meter. This check is accomplished by first calibrating the smoke meter according to 3.3.1 and then inserting a series of three neutral-density filters of nominal opacity of 20, 50, and 75 percent in the smoke meter pathlength. Filters calibarted within ±2 percent shall be used. Care should be taken when inserting the filters to prevent stray light from affecting the meter. Make a total of five nonconsecutive readings for each filter. The maximum error on any one reading shall be 3 percent opacity.

3.3.2.6 Zero and span drift. Determine the zero and span drift by calibrating and operating the smoke generator in a normal manner over a 1-hour period. The drift is measured by checking the zero and span at the end of this period.

3.3.2.7 Response time. Determine the response time by producng the series of five simulated 0 percent and 100 percent opacity values and observing the time required to reach stable response. Opacity values of 0 percent and 100 percent may be simulated by alternately switching the power to the light source off and on while the smoke generator is not operating.

4. *References.*

4.1 Air Pollution Control District Rules and Regulations, Los Angeles County Air Pollution Control District, Regulation IV, Prohibitions, Rule 50.

4.2 Weisburd, Melvin I., Field Operations and Enforcement Manual for Air, U.S. Environmental Protection Agency, Research Triangle Park, N.C., APTD-1100, August 1972. pp. 4.1-4.36.

4.3 Condon, E. U., and Odishaw, H., Handbook of Physics, McGraw-Hill Co., N.Y., N.Y., 1958, Table 3.1, p. 6-52.

Figure 9-1 Page____of____

RECORD OF VISUAL DETERMINATION OF OPACITY

COMPANY ____________	HOURS OF OBSERVATION ____________
LOCATION ____________	OBSERVER ____________
TEST NUMBER ____________	OBSERVER CERTIFICATION DATE ____________
DATE ____________	OBSERVER AFFILIATION ____________
TYPE FACILITY ____________	POINT OF EMISSIONS ____________
CONTROL DEVICE ____________	HEIGHT OF DISCHARGE POINT ____________

Record the following information prior to and upon completion of observations at each source. If observations are made over an extended period of time, additional recordings should be made as applicable.

CLOCK TIME INITIAL __:__ a.m. / __:__ p.m. FINAL __:__ a.m. / __:__ p.m.

OBSERVER LOCATION								
Distance to Discharge								
Direction from Discharge								
Height of Observation Point								
BACKGROUND DESCRIPTION								
WEATHER CONDITIONS								
Wind Direction								
Wind Speed								
Ambient Temperature								
SKY CONDITIONS (clear, overcast, %clouds, etc.)								
PLUME DESCRIPTION								
Color								
Distance Visible								
MINUTES OF NONCOMPLIANCE								

FIGURE 9-2 OBSERVATION RECORD PAGE ___ OF ___

COMPANY ____________	OBSERVER ____________
LOCATION ____________	TYPE FACILITY ____________
TEST NUMBER ____________	POINT OF EMISSIONS ____________
DATE ____________	

Hr.	Min.	Seconds 0	15	30	45	STEAM PLUME (check if applicable) Attached	Detached	COMMENTS
	0							
	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
	11							
	12							
	13							
	14							
	15							
	16							
	17							
	18							
	19							
	20							
	21							
	22							
	23							
	24							
	25							
	26							
	27							
	28							
	29							

FIGURE 9-2 OBSERVATION RECORD (Cont.)

PAGE ___ OF ___

COMPANY ____________
LOCATION ____________
TEST NUMBER ____________
DATE ____________

OBSERVER ____________
TYPE FACILITY ____________
POINT OF EMISSIONS ____________

Hr.	Min.	Seconds 0	15	30	45	STEAM PLUME (check if applicable) Attached	Detached	COMMENTS
	30							
	31							
	32							
	33							
	34							
	35							
	36							
	37							
	38							
	39							
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APPENDIX C

S 12. - GENERAL POLICY ON THE USE OF SECTION 114 AUTHORITY FOR ENFORCEMENT PURPOSES

S 12. - GENERAL POLICY ON THE USE OF SECTION 114 AUTHORITY FOR ENFORCEMENT PURPOSES

INTRODUCTION

The purpose of this guideline is to provide guidance relating to the exercise of the authority set forth in Section 114 of the Clean Air Act, as amended, for enforcement purposes.[1/]

USES OF SECTION 114

Use in Determining Status of Compliance

Section 114(a)(ii) provides that the Administrator may require the owner or operator of any source to provide information for the purpose of determining "whether any person is in violation of any such standard or any requirement of such a plan." This is one of the most important enforcement tools under the Clean Air Act, in that the source can be required to provide the information which may be the basis for enforcement action by EPA. Regions are urged to make extensive use of §114 for enforcement purposes since this is usually the most effective method of obtaining the necessary information to begin an enforcement action.

Uses During Emergency Episodes

Section 114(a)(iii) of the Act enables EPA to obtain information necessary to implement Section 303 authority (emergency episodes). During an emergency episode, it may be necessary to obtain recordkeeping by such owner or operator to ensure that he is taking appropriate action. This section can also be used to develop Section 303 emergency episode action plans, as discussed in General Enforcement Guideline S.15.

1/ Section 114(a)(1) enables the Administrator to require owners or operators of emission sources "to (A) establish and maintain such records, (B) make such reports, (C) install, use, and maintain such monitoring equipment or methods, (D) sample such emissions (in accordance with such methods, at such locations, at such intervals, and in such manner as the Administrator shall prescribe), and (E) provide such other information, as he may reasonably require." Section 114(a)(2) authorizes right of entry for certain purposes and the right of the Administrator to sample emissions.

REQUEST FOR INFORMATION

Section 114 Letter Format

The letter to an owner or operator should recite expressly that it is being sent pursuant to Section 114(a)(ii) or (iii), state specifically the information required, recite the penalties for non-compliance, and specify a reasonable time to answer. Generally it should be sent certified mail, return receipt required, to document receipt. In the letter, the Regional Office may require the source owner or operator to appear at a designated time and place to discuss the information required to be provided to EPA.

During an emergency episode a Section 114 letter should be delivered personally to the source owner or operator and a receipt should be obtained upon delivery.

Privilege Against Self-Incrimination

A problem may arise in the case of an individual who refuses to provide information on the grounds of the Fifth Amendment privilege against self-incrimination. This is not a problem with respect to a corporation, since a corporation does not have this privilege. However, except as discussed in the following, an individual, as opposed to the corporation, may refuse to answer any request for information under Section 114 if the information might tend to incriminate him. (See OGC memo dated 8/7/72). If an individual refuses to comply with the request for information on this ground, the Regional Office should consider itself on notice of a probable violation and should gather the information by other methods.

If the information needed from the source owner or operator is required to be kept under a recordkeeping provision of a State Implementation Plan, then the privilege may not be invoked, even by an individual. 2/ Thus, if an individual raises an objection on Fifth Amendment grounds, the State Implementation Plan should be checked to determine whether the plan requires such information to be kept by the source, and if it does, Fifth Amendment objections are not valid and the information must be provided.

2/ According to the Shapiro Doctrine, "the privilege which exists as to private papers cannot be maintained in relation to 'records required by law to be kept in order that there may be suitable information of transactions which are the subject of governmental regulations and the enforcement of restrictions validly established'".

The Section 114 letter need not call to the attention of the source owner or operator that he may have a right to invoke the privilege against self-incrimination nor need this be done at an onsight investigation. The *Miranda* warning is required only where a person is "in custody".

Federal Reports Act

Section 114 letters sent to persons suspected of being in violation of an implementation plan requirement or Section 303 are not subject to the Federal Reports Act. Identical letters may be sent to multiple sources without the need for securing OMB approval since this use of Section 114 is an enforcement function rather than the gathering of technical data for standard setting purposes.

Before sending out a Section 114 letter, check the NEDS data bank to determine whether EPA already has such information. However, where immediate enforcement action is contemplated, the Regional Offices should direct a Section 114 letter to the source regardless of the results secured from the data bank. Duplication of reported information can be avoided by advising the source of the information in our possession and affording the source the opportunity to confirm such information as responsive to the Section 114 inquiry. This practice will be necessary because information employed for enforcement purposes must constitute reliable evidence on the present status of compliance and be so represented by the source under pain of penalty for any misrepresentation. To proceed otherwise presents the prospect that a source may repudiate information in our possession on which we base a finding of violation, and we then would be forced to gather further proof to verify and substantiate our determination before commencement of any judicial proceedings.

Trade Secrets

It is anticipated that some of the information required by Section 114 letters will contain trade secrets. Although the information asked for must be provided, the source owner or operator can designate certain portions of his response confidential and EPA must treat it as such unless and until the Administrator determines that it is not entitled to protection as a trade secret. This determination should be made after the information has been submitted, if either the source owner or operator requires that such a determination be made or if someonw else requests the information from EPA. Regional Offices can also make these determinations on their own initiative to keep down the amount of material which must be afforded confidential treatment. No determination or agreement will be made concerning trade secrets status prior to receipt of the

Section 114 information. The regulations in 40 CFR Part 2 outline the EPA procedures for making this determination.

ENTRY AND INSPECTION

Section 114(a)(2) enables the Administrator or his authorized representative to enter a source so that EPA can do its own monitoring, sampling, inspecting or copying of records. This authority also can be used to determine whether a source is carrying out any obligations imposed on it by EPA under Section 114(a)(1).

The term "authorized representative" would include specific individuals from each Regional Office, preferably permanently designated to give a sense of continuity and familiarity with the tasks. This does not mean that other Regional Office or EPA employees cannot perform such tasks on an ad hoc basis when necessary to achieve EPA objectives.

A contractor for EPA or other person assisting EPA in carrying out its functions may be designated as an "authorized representative" for specific purposes which should be stated in a letter granting such representative status to the contractor. However, if the contractor is refused entry by the source owner or operator despite this letter, it is not advisable to request a U.S. Attorney to obtain a search warrant to gain entry for the contractor, since a judge would most likely refuse to issue one. EPA personnel should perform the task themselves if such a situation arises or accompany the EPA contractor performing the work.

Where a state has been delegated Section 114 authority from EPA, the same authority EPA has to monitor, sample, inspect or copy records, and any other authority under Section 114(a)(1) and (2) of the Clean Air Act can, in like manner be exercised by the State. No representative of EPA need accompany the state officials.

Section 114(a)(2) requires that the person exercising the right of entry should have credentials. EPA has established a procedure governing the issuance and control of credentials. Regional Offices may obtain such credentials in accordance with the procedures. The Regional Offices can still issue their own credentials to carry out Section 114 in the period until the procedures in the EPA order can be implemented or in unusual circumstances. If the Regional Office chooses to issue its own credentials in such instances, such credentials should contain the agency name; the bearers name, signature, and photograph; the division in the agency with thich he is employed; the quotation of Section 114 authority under which entry is sought; and a citation of the penalties for noncompliance with Section 114. The credentials should be signed by the Regional Administrator. Credentials can also be issued by the Regional Office in the form of a letter on an ad hoc basis where there is not sufficient time to obtain more permanent credentials. The letter should contain all of the information that is in the permanent credentials except the photograph and signature of the bearer.

Entry for Section 114 purposes should be confined, except in emergencies, to normal business hours to minimize inconvenience to the source.

Safety Equipment

A source owner or operator has no responsibility to supply EPA inspection teams exercising Section 114 authority with safety equipment such as hard hats or shoes. EPA should provide whatever equipment is necessary for an inspection team to safely perform those duties entrusted to them by law.

Visitors Releases

Members of inspection teams exercising Section 114 authority should not sign waivers or "visitors releases" that would absolve the company of responsibility of injury due to negligence. In a memo to all Regional Counsels dated November 8, 1972, from John Quarles, it is stated that "Inasmuch as the Clean Air Act . . . grant(s) EPA employees a right of entry to corporate facilities, a company may not lawfully condition the exercise of this right upon the signing of a release or indemnity agreement." "When a firm refuses entry to an EPA employee performing his function under the Clean Air Act, the employee may appropriately cite the statute and remind the company of EPA's right to seek judicial enforcement. If the company persists in its refusal, EPA should go to court in preference to signing a 'Vistors Release'".

Search Warrants

If a source owner or operator refuses to admit EPA authorized representatives attempting to exercise Section 114 responsibilities, entry cannot be made until a search warrant is obtained. Appropriate Regional personnel should be notified so that they can request that the U.S. Attorney obtain a search warrant. (DSSE is developing a model application for a search warrant and a model search warrant for use by the Regional Offices). If any delay is anticipated from a source in permitting the exercise of Section 114 authority and such delay is unacceptable to the successful completion of EPA tasks, a search warrant should be obtained. If delay is anticipated even with a search warrant, it can be requested that the search warrant be written so that immediate entry be granted.

ENFORCEMENT PROCEDURES

Section 113(a)(3) provides that if the Administrator finds that any person is in violation of any requirement of Section 114, he may bring a civil action or issue an administrative order. Guideline S4. outlines procedures relevant to the commencement of a civil action or issuance of an administrative order.

In cases of failure to comply with Section 114, issuance of an administrative order is more appropriate. However, in most cases regional enforcement personnel will want to phone the source prior to the issuance of such an order to determine the reasons for the source owner or operator's failure to comply. If the source owner or operator continues his refusal to comply after the phone call, issuance of the order should proceed. The order should include a final date for compliance, and should specify a date for an opportunity to confer pursuant to Section 113(a)(4) prior to the effective date of the order. If the source owner or operator violates the order, civil and criminal action will then be appropriate.

While there are no criminal penalties for refusing to comply with Section 114 per se, a knowing failure to comply with any order issued under Section 113 relating to a Section 114 violation would subject the violator to criminal penalties of up to $25,000 per day or imprisonment for not more than one year, or both, for the first offense. Criminal penalties are also appropriate in the case of any person who knowingly makes any false statement or tampers with any monitoring device. The criminal penalties specified in Section 113(c)(2) for a violation of this type are a fine not to exceed $10,000 or imprisonment for not more than six months, or both. (See Guideline S.0, General Policy on Commencement of Criminal Actions Pursuant to Section 113(c)).

APPENDIX D

SUGGESTED CONTENTS OF STACK TEST REPORTS

CONTENTS OF STACK TEST REPORTS

In order to adequately assess the accuracy of any test report the basic information listed in the following suggested outline is necessary:

(1) Introduction. Background information pertinent to the test is presented in this section. This information shall include, but not be limited to, the following:
   (a) Manufacturer's name and address.
   (b) Name and address of testing organization.
   (c) Names of persons present, dates and location of test.
   (d) Schematic drawings of the process being tested showing emission points, sampling sites, and stack cross-section with the sampling points labeled and dimensions indicated.
   (e) Brief Process Description

(2) Summary. This section shall present a summary of test findings pertinent to the evaluation of the process with respect to the applicable emission standard. The information shall include, but not be limited to, the following:
   (a) A summary of emission rates found.
   (b) Isokinetic sampling rates achieved if applicable.
   (c) The operating level of the process while the tests were conducted.

(3) Procedure. This section shall describe the procedures used and the operation of the sampling train and process during the tests. The information shall include, but not be limited to, the following:
   (a) A schematic drawing of the sampling devices used with each component designated and explained in a legend.
   (b) A brief description of the method used to operate the sampling train and procedure used to recover samples.

(4) Analytical Technique. This section shall contain a brief description of all analytical techniques used to determine the emissions from the source.

(5) Data and Calculations. This section shall include all data collected and calculations. As a minimum, this section shall contain the following information:
   (a) All field data collected on raw data sheets.
   (b) A log of process and sampling train operations.

(c) Laboratory data including blanks, tare weights, and results of analysis.
(d) All emission calculations.

(6) Chain of Custody. A listing of the chain of custody of the emission test samples.

(7) Appendix:

(a) Calibration work sheets for sampling equipment.
(b) Calibration or process logs of process parameters.

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA 340/1-77-002	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Inspection Manual for Enforcement of New Source Performance Standards: Basic Oxygen Process Furnaces		5. REPORT DATE 6. PERFORMING ORGANIZATION CODE February 1977
7. AUTHOR(S) M.D. High, M.E. Lukey, T.A. Li Puma, R.F. Krzmarzick		8. PERFORMING ORGANIZATION REPORT NO.
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15. SUPPLEMENTARY NOTES

One of a series of NSPS Enforcement Inspection Manuals

16. ABSTRACT

This document presents guidelines to enable enforcement personnel to determine whether new or modified basic oxygen process furnaces comply with New Source Performance Standards (NSPS). Key parameters identified during the performance test are used as a comparative base during subsequent inspections to determine the facility's compliance status. Basic oxygen process furnaces, atmospheric emissions from these furnaces, and emission control methods are described. Inspection methods and types of records to be kept are discussed in detail.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Basic Convertors Steel Oxygen Blow Convertors Air Pollution	Basic Steel Industry	13B 14D 11F

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