PUBLISHED TECHNICAL PAPERS ON PLANT EQUIPMENT OPERATIONS & REGULATORY COMPLIANCE

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PREFACE

The following is a series of technical articles on boilers, power generation ,and various process equipment operation, the applicable local regulatory requirements, as well as the recommended control /mitigation measures for meeting the compliance requirements. These articles were published in the Los Angeles Textile News between the years 2000 to 2003 to guide plant engineers and managers in the process equipment air & water quality compliance with the local regulatory agencies, and in upgrade of the existing or selection of new compliant equipment. Additional technical papers on process equipment used in plant operations, associated emissions, and suitable control equipment were also presented by the author at seminars and workshops between 2005 and 2012, which are also included in this text. Although some of the local regulations (such as AQMD rules) may have been revised or updated since the initial publication date, but the specified control or mitigation measures in most cases still remain in effect. However, due to the nature of regulatory business, it is recommended that the reader keeps track of the updates for the specified regulations in this text.

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BOILER'S RETROFIT OR REPLACEMENT

The Most Suitable Alternative for Compliance with the SCAQMD Rule 1146.2

The SCAQMD Rule 1146.2 was adopted on January 19, 1998. The intent of this rule is to regulate the NOx & CO emission concentration of small boilers and process heaters between 75 thousands to 2 million Btu/Hr. The compliance schedule is dependent on the equipment heat input rate. For process heaters between 75 thousands to 400 thousands Btu/Hr, it is the manufacturer's responsibility to obtain the SCAQMD certification for meeting NOx & CO limit for units that are built after January 2000. However, units with higher heat input rating need to show compliance with Rule 1146.2 by the equipment owner or operator. RECLAIM facilities are exempt from Rule 1146.2 requirements.

By July 1, 2002, all boilers with the heat input rating between 1 to 2 million Btu/Hr that were manufactured prior to January 1992 must submit application form 222 along with source test result or manufacturer's certification that shows compliance with NOx & CO concentration limits of 30 ppmv & 400 ppmv, respectively.

To determine the compliance status of the boilers at the specified range, the facility operator or owner need to conduct a source test per SCAQMD approved test protocol. If the test result shows NOx & CO concentration higher than SCAQMD emission limits, one of the following options could be pursued:

1. Retrofitting the boiler with a low NOx burner or flue gas re-circulation
2. Replacement of the existing boiler with a new boiler that meets the NOx & CO limits
3. Utilizing the existing boiler for no more than 9000 Therms per year

The facility operator also has the option to de-rate the boiler to 1 million Btu/Hr or less. However, on January 1, 2006, the boilers and process heater between 400 thousands to 1 million Btu/Hr also need to meet the NOx & CO concentration limits. The boilers that were manufactured from 1992 to 1999 need to meet the NOx & CO concentration limit by January 1, 2005.

It needs to be added that all operators that choose the option to operate the boiler with less than 9000 therms per year must show proof of the actual fuel usage of the subject equipment. The proof could be provided through installation of an independent fuel meter or a mechanical device that could establish the actual operating hours of the equipment.

Achieving compliance with Rule 1146.2 requirements could take between 3 to 4 months. Therefore, to avoid missing the SCAQMD deadline and facing potential fines from the SCAQMD enforcement office, it is recommended that the dye house operators to start evaluating their options now.

FINANCIAL BENEFITS OF UPGRADING YOUR PLANT'S WASTEWATER TREATMENT SYSTEM

The local fabric dyeing & finishing facilities generally limit the treatment of their process wastewater discharges to neutralization and filtration only. The basic treatment process protects the facility operator against wastewater discharges that are either acidic, corrosive, or contain high concentration of suspended solids. However, it does nothing to reduce the Chemical Oxygen Demand (COD), excessive coloration, high temperature, peak flow or any odor that may be associated with the effluent.

Among the above mentioned effluent parameters, excessive coloration, high temperature, or odor are considered non-compliant and nuisance problems that violate the local, state, and federal water quality rules and are required to be corrected by the regulatory agency. The other parameters, like high COD content and high peak flow rate, are generally not in violation of the Los Angeles County wastewater discharge rule. However, discharging an effluent with high COD content and high flow rate is not without a cost. In fact, a major portion of the annual sewer surcharge fee and excess capacity unit charges is attributed to these two parameters.

The dye house operators in Los Angeles County are limited to a basic daily wastewater discharge capacity unit. An increase of 25% or more of the facility capacity unit will result in payment of excess capacity unit charges. To avoid the excess capacity unit charges, which for some dye houses in the County in payment of as high as $750,000, upgrading of the wastewater treatment system maybe the most cost-effective option.

One must beware that although most dye houses may run the same type of operation, the cost of upgrading the system is not the same for everyone. Depending on the number of sources of discharges and the flow rate, a system upgrade may cost as low as $10,000 or exceed $100,000 for facilities with greater than 250,000 gallons of wastewater discharge per day.

A wastewater system upgrade generally consists of COD, excessive coloration, and odor removal system through carbon adsorption or oxidation, plus peak flow reduction through installation of flow equalization system.

To determine the cost effectiveness for upgrading the wastewater treatment system, the facility operator could install pilot scale treatment units on temporary basis. The pilot scale type treatment system is available on lease term basis for a fraction of the cost of a full-scale unit. Results achieved through the pilot program would determine if upgrading of the system would be advantageous.

It also needs to be added that proper monitoring & operation of the wastewater treatment through training of the staff will contribute further to cost reduction and compliance with the Los Angeles County wastewater discharge requirements.

ONSITE POWER GENERATION, COULD IT WORK FOR YOU?

The hike in prices of natural gas and electricity during the January to May of last year resulted in forcing many of the local dye house operators to search for various alternatives to reduce the plant's utility cost. Some facility operators fearing greater rise in fuel and electricity costs got into binding fixed term contracts, while others reduced their operating hours and production rate, and some found no choice but to shut down their operation to prevent further financial losses.

However, one of the potential alternatives that has been overlooked by most fabric dyeing & finishing operations is onsite power generation. This alternative is more attractive now to facility operator for two reasons:

1. lowering of natural gas prices
2. enactment of AB 970 State incentive program.

Potential Financial Benefits

An onsite power generator, simply utilizes natural gas to generate electricity and steam/ hot water. The exhaust heat resulting from the combustion of natural gas in turbine or engine is recovered via the plant boiler for heating the water into pressurized steam.

As a result the plant boiler does not need to operate on mid or high capacity during the production period. Furthermore, the generated electricity will reduce the high peak and mid peak charges by the utility company during the winter and summer months.

The additional saving that plant operator can be entitled to per Assembly Bill 970, is up to 50% of equipment purchase and installation of a power generation and heat recovery unit. AB 970 was signed on September 6, 2000 . Under this legislation the California Public Utility Commission (CUPC) is required to implement the self generation incentive program. The maximum unit size is 1000 K.W. or 1 M.W. The incentive is divided into three different categories, of levels 1, 2 and 3. Levels 1 & 2 apply to utilization of photo voltaic, wind turbines & fuel cells, and pay up to 40% to 50% of the project cost. Level 3 applies to more traditional methods of power generation that consist of utilization of IC engines with heat recovery or micro-turbines utilizing waste heat. Up to 30% of project cost for level 3 power generation system will be reimbursed for facilities qualified under the incentive program.

Southern California Gas Company is the agency that screens, reviews and qualifies the facilities that apply for the AB 970 program. The annual funds allocated for this incentive program by CPUC to Southern California Gas Company is around $13 million dollars. The funds are allocated to qualified applicants on first come, first served basis.

The qualification requirements

To qualify for the incentive program, the facility must not be under any agreement with their existing power supplying company for interruptible services. The annual average peak demand should not be less than the size of power generation & heat recovery unit, and the system need to be connected to the electrical grid. The proposed overall power generation & heat recovery system efficiency should be greater than 42.5%. In general, a properly sized system will have an efficiency of greater than 50%.

How can you determine that your facility qualifies for the incentive program?

In order to determine that your facility could qualify for this program, a thorough evaluation of the gas, electricity, and water usage bills need to be conducted. Provided that the facility annual average peak demand rate, hot water/ steam usage, merits utilization of onsite power generation unit, than a cost /benefit analysis which includes detailed evaluation of power generation equipment capital, operating & maintenance cost, installation cost, city & county permitting requirements and cost need to be performed by a qualified engineer.

PLANT RELOCATION COULD BE COST EFFECTIVE

Many of the local dye house operators lease their property. The lease term generally vary between 5 to 10 years. A few months prior to termination of the lease agreement, the dye house manager / owner starts the negotiation with the property owner for renewal or extension of the lease. However, if the offered lease price is higher than the anticipated market value, the facility manager often feels that there is no choice but to renew the lease at higher price, since moving to a new location could be too costly.

Although plant relocation may entail major expenditure, it does not necessarily mean that moving to a new location is more expensive than the increase in rent for the entire duration of the lease. But, to verify that the facility relocation is less costly than lease renewal, the plant owner or manager needs to conduct a comprehensive evaluation of potentially suitable sites at least six month prior to expiration of the lease.

Choosing of a proper site for dyeing operation can not be based solely on property's size and rental rate. There are many other factors that need to be considered and evaluated. These factors could be divided to the following two categories of operational, and environmental.

Operational Factors

Regardless of the type of manufacturing operation, the facility manager must verify that the proposed site provides adequate supply of gas, water, and electricity for operating the plant equipment at the maximum rating. Modification of the site through installation of gas compressors, rerouting of piping & plumbing or installation of electrical transformers is costly. Such an expenditure is generally not needed if the property is classified for industrial occupancy. Changing the occupancy permit form commercial to industrial is time consuming and requires major modifications. The modifications are generally required by the local fire department and may include installation of additional separation walls within different areas of the plant, separate ventilation & fire sprinkler system for the stored raw materials, and waste storage areas. In general, conversion of a commercial facility to an industrial facility is costly and is not recommended.

The other operating parameters that need to be checked for selection of a proper site for a dye house is adequate platforms for delivery and transport of fabrics and raw materials, additional warehouse and storage space for finished fabrics and raw materials is also a plus.

Proximity of the proposed site to the business center is also an advantage. Being close to the customers base, saves time and money. However, such a benefit needs to be weighted in relation to spaciousness, building classification and the area 's rental rate.

Environmental Factors

One of the major environmental factors for any dye houses in the Los Angeles County is the facility's baseline capacity unit. The baseline capacity unit is the amount of wastewater discharge that is allowed by the local city and county sanitation district from the fabric dyeing operation at the facility. The capacity unit charges were implemented by the Los Angeles County Sanitation District in 1981 to finance the construction and operation of public wastewater treatment centers needed for the large number of discharges in the County. If the proposed site's capacity unit is lower than the anticipated facility daily wastewater discharge, a sewer connection fee and excess capacity unit fee must be paid to the Sanitation District. A new facility with an excess capacity unit of 10 million gallons per year may end-up paying more than $400,000 for sewer connection fee. On the other hand, there are no capacity unit charges for facilities located outside Los Angeles City and County, such as Orange County, Riverside County, or San Bernardino County. Permitting of the operating equipment by the South Coast Air Quality Management District also needs to be taken into account. In general, if the existing process combustion equipment, such as the tenter frames that process synthetic fabrics and dye house printers are equipped with Best Available Control Technology (BACT), there will be no hurdle in obtaining the air quality permits. Otherwise the subject equipment must utilize BACT. Therefore it is essential that all the permitting requirements by City, County, or the District to be thoroughly evaluated prior to equipment relocation. Proximity to sensitive receptors such as schools, and hospitals also need to be considered. To avoid issuance of public notice and risk assessment studies, a distance of grater than ½ mile from sensitive receptors is recommended.

Once all of the above factors are taken into consideration you could determine whether relocating your facility will be less expensive than renewal of the lease for additional years. It needs to be noted that since many of the variables used in conducting the study are based on current market data and existing regulatory requirements, the recommendations only remain valid if the factors used in the evaluation do not fluctuate or vary widely over time. Therefore it is essential that this evaluation to be performed by a technical person in consultation with an industrial property broker. An industrial property broker could assist you in answering the pertinent questions in terms of area's zoning and space suitability. But technical questions on pertinent operational parameters, and the city & county requirements plus the associated expenses could only be answered by performing a site specific feasibility study.

COMBUSTION MONITORS COULD REDUCE THE PLANT'S FUEL USAGE COSTS

Reducing the plant's energy cost while maintaining the normal production rate is the top priority of most fabric finisher and dyer plant owners and managers.

One of the rather low cost methods to determine the combustion type equipment, such as the boilers fuel usage efficiency on a continuous basis is through installation of carbon monoxide monitor, or oxygen monitor on exhaust line.

Generally the lower the carbon monoxide or the oxygen concentration at the exhaust outlet indicate the better combustion of fuel, and conversion into carbon dioxide and water.

Burner's tune up is a part of plant boiler's general maintenance. During the tune-up, procedure the air / fuel ratio, temperature, carbon monoxide, and oxygen concentration of the exhaust stream is measured. An oxygen or carbon monoxide concentration of 3% or less for a boiler generally indicate a good combustion efficiency or proper air / fuel ratio. A higher percentage of carbon monoxide or oxygen concentration is signals of excess dilution air, heat loss, low efficiency combustion and higher fuel usage.

So, installation of exhaust carbon monoxide, or oxygen monitoring is a good way to be informed on boiler's burners operating efficiency. Furthermore, installation of the monitoring system will reduce the boiler's tune-up requirements by South Coast Air Quality Management District (This applies to boilers greater than 5 MMBtu/Hr) from twice a year to once per year.

The general cost of a carbon monoxide or oxygen exhaust monitoring system is between $5,000 to $7,000. The monitored data could also be downloaded into the computer by installing a modem and utilizing the proper communication software.

The selection and installation of the combustion monitors are conducted by air quality engineering firms that are specialized in emission monitoring system integration.

HOW TO PREVENT VIOLATION OF AIR & WATER RULES (Part I)

This article is prepared as a two part series on air & water quality compliance issues for the fabric finishing & dyeing facilities in southern California. The first part of this series will mainly deal with the air quality issues.

Source Of Air Emissions

The primary air pollutants that are generated from operation of fabric processing equipment consist of Nitrogen Oxides (NOX), particulate Matters (PM_{10}) & Volatile Organic Compounds (VOC).

The NOX emission results from the gas combustion process and is generated from operation of gas burning equipment in the plant such as boilers and tenter frames. Drying of 100% or partially synthetic fabrics in the tenter frame will result in discharge of visible emission (white smoke). The smoke is generated due to high concentration of oily particulate matters. The particulates matters are required to be controlled by an air cooled or water cooled electrostatic precipitator (ESP) or scrubber system.

The other source of air contaminants is the textile printing press which generates VOC emissions. The VOC emissions are generated from the usage of ink or organic solvents in silk screening or printing process. The VOC emissions are required to be controlled by carbon adsorption or thermal oxidation systems.

What Are the Typical Air Quality Violations in a Dye House

The type of air quality rule violations that could occur in a dye house can be divided into two categories; permit condition violations, and SCAQMD source specific, prohibitory, & BACT rule violations.

The permit violations generally consist of exceeding the limits imposed on tenter framers fabric processing rates, operating temperatures, NOX concentration, or fuel usage. Similarly a Notice of Violation could be issued if the boiler exceeds the fuel usage, NOX or oxygen concentrations or the semi-annual tune-up requirement. Violation of permit condition for a textile printer could consist of the type of material used or the usage rate.

The applicable rule that apply to textile facilities consist of prohibitory Rules 401, 402, source specific Rules 1128, 1130, 1146, and Regulation XIII BACT Rule 1303 & 1306.

The prohibitory rules regulate the visible emission and potential nuisance that could be generated through lack of maintenance or break down of particulate control equipment on the fabric tenter frames.

The source specific rules limit the amount of VOC in the compounds used in the fabric printing or silk screening process. Rule 1146 limits the NOX emission concentration from the plant boilers. REG XIII Rule 1303 & 1306 apply to uncontrolled sources and require installation of control equipment for reduction of particulate matters, NOX & VOC emissions.

A Notice of Violation could be issued for non-compliance to any of above stated requirements. However, a facility operator could prevent issuance of a Notice of Violation through conducting periodical (quarterly or semi-annual) facility audit. The facility air quality audit could be conducted by the plant's environmental engineer or a consultant who is familiar with textile operation and applicable air quality regulations.

What Should Be Include in a Facility Air Quality Audit?

1. Evaluation & review of the existing equipment permits.
2. Evaluation & review of the daily, & monthly material & fuel usage records per applicable SCAQMD rules.
3. Evaluation & review of the burner's tune-up records per SCAQMD Rule 1146.
4. Evaluation & review of the equipment source test reports.
5. Review of the non-permitted equipment at the plant to assure that they remain to be exempt per current SCAQMD Rule 219.
6. Review of the equipment and facility annual emission report.
7. Review of the basic & control equipment maintenance records.
8. Evaluation & observation of the air pollution control equipment and determination of the control efficiency during the maximum production period.

Per gathering of the above data, the plant manager can determine if the facility equipment are operating efficiently and in compliance with the SCAQMD requirements. In case of observation of any non-compliance issues, the facility operator should request a variance from the SCAQMD hearing board. The procedure for obtaining the variance from permit conditions will be discussed in the next issue.

HOW TO PREVENT VIOLATION OF AIR & WATER RULES II

The following article is the 2nd & final part of a series on avoiding violations of air & water quality rules.

The purpose of an air quality audit is to assure that the facility is operating in compliance with the specified permit conditions and applicable State & Federal rules. However, if per conducting of audit it is determined that any of the equipment are operating contrary to the permit conditions, the facility operator must either stop the operation of the equipment & correct the problem, or file a petition for variance from the subject condition with the SCAQMD Hearing Board. The SCAQMD Hearing Board may allow a temporary variance form the permit condition until the problem is corrected. General types of variances could include request for revision of equipment fuel usage limit, or a higher NOX emission rate from a boiler or tenter frame. Variance could be granted on a short term, 90 days, or regular, six months to one- year period.

The water quality rules in southern California are not enforced by a single agency. In fact, each county, or in certain areas, cities, such as the city of Los Angeles, have their own regulatory agency. Water quality regulatory agencies generally inspect the permitted facilities on an annual basis, and monitor a set of parameters that include the wastewater discharge rate, turbidity or solid concentration of the discharge, odor, pH, color and temperature of the effluent. Depending on the facility permit, additional parameters, such as sampling & monitoring of heavy metals or soluble sulfide may also be required.

Los Angeles County Sanitation District (LASCD), which has jurisdiction over the largest number of dye houses in the basin, requires frequent sampling and reporting of the wastewater discharge analysis. Depending on the facility flow, the reporting frequency could be on a weekly, monthly, or quarterly basis. The purpose of Self Monitoring Report (SMR) is to assure compliance with the facility wastewater discharge permit conditions, and is used to estimate the annual surcharge fee that needs to be paid to LACSD at the end of each fiscal year.

To avoid violations of facility permit conditions, implementation of the following measures is recommended.

1. Installation of an online pH monitor.
2. Installation of automatic feed caustic solution tank to balance pH whenever the influent becomes acidic.
3. Periodic cleaning of the filtration system.
4. Installation of an online chlorination system to avoid discharge of highly concentrated dyes in red, blue, black etc., and reduction of COD concentration.
5. Installation of a temperature monitor / controller for observation of the effluent temperature.
6. Installation of a wastewater discharge flow meter with a chart recorder

7. Installation of a flow equalization tank to reduce peak flow and maintain daily flow rate.
8. Installation of a rinse water recycling system to reduce the daily flow discharge and to save on water cost, sewer connection and annual surcharge fees.
9. Periodic sampling and monitoring of wastewater discharge to assure compliance with the effluent limits.
10. Semi-annual training of the staff on record keeping and monitoring requirements.

The above ten recommendations will assure the facility operators remain in compliance with the water quality rules requirements and could result in financial benefits for the dye house owner.

FINANCIAL AND ENVIRONMENTAL BENEFITS OF WATER RECYCLING
PACIFIC TEXTILE NEWS FEBRUARY 2001

Most Dye houses consume a large amount of water for fabric coloring and rinsing operations on a daily basis. On average, the amount of water used for rinsing jet machines exceeds 50,000 gallons per day for a medium-sized dye house.

The environmental benefits of water recycling are many, but the two most important ones are preservation of our precious natural resources, and prevention of water pollution. There may not be any financial incentive in recycling of the total wastewater discharges from the fabric coloring and washing equipment, due to high quality requirements for recycled water, which means an extended level of treatment and various types of equipment are needed. However, most dye houses could benefit finacially from recycling of their jet machines rinse water. The rinse water is used for cleaning of the jet machines after completion of each cycle. Since the contamination level is low in the rinse water, it could be easily removed by continuous filtration process.

Annual Savings	
Savings area	Savings
Water Bills	$36,000
Wastwater Surcharge Fees	$10,000
Wastewater Treatment Cost (chemical, disposal)	$5,000
Annual Savings in Electricity	$2,000
Fuel Cost	$12,000
Total	**$65,000**

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A Look at the Basics

The basic equipment needed for recycling rinse water includes two above ground water holding tanks, tank water heaters, two water delivery and return pumps, a properly sized water filtration unit, and a water temperature indicator. The capital cost of the rinse water recycling equipment is based on the water holding capacity of the unit, with the estimated cost for a system that is capable of recycling 50,000 gallons of water on a daily basis at around $35,000.

The estimated savings that could be achieved in a dye house through recycling of 50,000 gallons per day of rinse water is shown above (see table).

In addition, newly built dye houses in Los Angeles County, which have no excess sewer capacity units, could save up to $75,000 in sewer connection fees, per recycling of 50,000

gallons per day of rinse water. Based on the above estimates, a rinse water recycling system payback period is less than one year.

More Savings

Another area to find potential savings is in the installation of a flow equalization tank for the dye houses that operate one or two shifts per day. The flow equalization system will reduce the Los Angeles County Sanitation District peak flow charges that could reach as high as $10,000 per year for a medium size dye house. The peak flow equalization system consists of a water transfer pump, a holding tank, and a discharge valve. The estimated cost for an above ground 2,500 gallon capacity system is around $6,500.

Water recycling and flow equalizations systems will save money and are efficient when designed properly and tailored for specific applications. Design specifications for water recycling and flow equalization systems are prepared by consulting engineering firms specialized in water quality areas.

WORD TO THE WISE: PUT EXPANSION PLANS TO COST-BENEFIT TEST
PACIFIC TEXTILE NEWS MARCH 2001

Gas, water, and electrical usage account for a large percentage of the costs for most domestic fabric finishing and dyeing plants. Other major costs include: annual air emission, wastewater surcharges, and waste disposal fees.

So, the equipment capital cost should not be the only factor considered when adding a new tenter frame dryer, a jet dyeing machine, or a boiler. Operating expenses and the environmental compliance costs are also an important part of the evaluation study.

Generally, plant managers consider the production capacity and maintenance requirements as the main factors in choosing new equipment. However, there are many additional environmental and operational factors that need to be considered—and many plant managers may not be aware of these factors. The consideration of such factors could get more complex, too, if several different types of equipment are added in a major plant expansion or relocation.

A complete cost-benefit analysis is a key to determining the most cost-effective way to implement a proposed equipment addition or plant expansion. An engineer who is familiar with the proposed equipment technical specifications as well as local, state, and federal environmental regulations should conduct the analysis. In some instances, the amount of air emissions may be the most critical factor in choosing the right equipment.

Some operators—instead of buying new equipment—may benefit more by replacing existing process equipment with larger capacity equipment that is more efficient and pollutes less. In some cases new equipment may make sense on a cost-benefit basis. In any case, it's certain that Southern California has strict air pollution control standards that require a large number of facilities to reduce their NOX emission on an annual basis. Depending on the facility's emission limit, plant expansion without replacing or retrofitting the old equipment may become a very costly option.

A cost benefit analysis is good for more than equipment additions. It also is important in choosing a location for a facility, and for selecting and installing energy recovery/cogeneration systems, as well as air and water pollution control equipment.

A cost benefit analysis used in selecting a location would take into account the city and county requirements, establish the cost of compliance, and determine if the site is suitable for an industrial operation.

A chief factor in evaluating energy recover/cogeneration systems is the annual expenses for gas and electricity compared with the cost of annualized capital, operation and maintenance of the system. The installation of a cogeneration system is considered cost effective if the annualized cost of the cogeneration system is less than the plant's annual utility bill. (A life term of a cogeneration system is estimated to be from 15 to 20 years.).

A cogeneration system would reduce the burden on the plant's boilers by heating the water for the jet machines as well as supplying the plant electricity. Such a system could result in a lowering of air emission, reduce the dependence on the electricity supplied by the power interruption and plant shut downs.

Finally, most facility owners are aware that there is more than one type of air or water pollution control system that reduces the plant emissions. A comparative cost benefit analysis is necessary in order to determine the most economical system for a specific kind of operation.

A recent installation of a combined air pollution control system and a heat recovery system at a large Southland fabric dyeing and finishing facility could be used as a good example in cost/benefit analysis. The facility's owner was required to install an air pollution control system on a tenter frame to reduce visible emission (smoke) from the drying of synthetic fabrics. The traditional control equipment for the visible emission is a double stage electrostatic precipitator (ESP)—or combined scrubber and ESP system.

The facility manager chose a thermal oxidizer with heat recovery system, rather than a traditional air pollution control system. The main advantages to the combined thermal oxidizer/heat recovery system include a reduction of the thermal load on the plant boilers, capability for providing additional hot water, and the decrease in the facility's NOX and CO emissions (The control equipment emissions are exempt emissions.).

The decrease in the facility emissions is not only the result of a more efficient burner of the thermal oxidizer. Indeed, the decrease is mainly due to the fact that NOX emission generated by the control equipment is considered exempt and therefore no emission offset is required. This alternative could be valuable to a RECLAIM facility that needs to purchase additional NOX RTC emission credit on an annual basis. The recovered heat is used to raise the water temperature, provide hot water for the plant's jet machines, and therefore reduces the NOX emission and load on the boilers.

There are many advantages in conducting a cost benefit analysis, but the most important one is the fact that a thorough engineering cost analysis serves as insurance against excessive capital and operational expenditures.

SIERRA ENGINEERING SERVICES

NOx Control Technologies For Gas & Oil Fired Equipment

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List of Equipment that Required NOx Reduction

- Boiler
- Internal Combustion Engine
- Drying Oven
- Process Heater
- Furnace
- Gas Turbine

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NOx Composition

NOx = Combined Oxides of Nitrogen ($NO + NO_2$)

Total NOx = Fuel NOx + Thermal NOx

Fuel NOx = Portion of NOx emissions formed per oxidation of Nitrogen in the fuel

Thermal NOx = Portion of NOx emissions due to disassociation of diatomic Nitrogen per high temperature in the combustion flame zone

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NOx Reduction Technology

- Combustion Control Technology
- Post Combustion Control Technology

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NOx Reduction Technology

- Combustion Control Technology
- Post Combustion Control Technology

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Applicable Combustion Control Technology

Boilers (1,2,3,5)

Process Heater (1,3,5)

Drying Heater (1,5)

Furnace (1,3,4,5)

IC Engine (5,6)

Gas Turbine (7)

1. **Low NOx Burner**
2. **Flow Gas Recirculation**
3. **Lower Excess Air Fire**
4. **Radial Staging**
5. **Lower Nitrogen Fuel**
6. **Retard Ignition**
7. **Steam Injection**

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Post Combustion Control Technology

Boilers (1,2,4)

Process Heater (1,2,4)

Furnace (2,4)

IC Engine (2,3,4)

Gas Turbine (2,4)

1. **Selective Non-Catalytic Reduction (SNCR)**
2. **Selective Catalytic Reduction w/UREA or Anhydrous Ammonia**
3. **Catalytic Oxidation**
4. **Selective Catalytic Reduction w/Aqueous Ammonia Injection**

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Post Combustion Technology

1. Selective Non-Catalytic Reduction (SNCR)

2. Selective Catalytic Reduction (SCR)

w/ Urea, or Anhydrous Ammonia

$$4\ NO + 4\ NH_3 + O_2 \longrightarrow 4\ N_2 + 6\ H_20$$

3. Selective Catalytic Reduction (SCR)

w/ Aqueous Ammonia Injection

$$NO + 2\ NH_4OH + O_2 \longrightarrow 3/2\ N_2 + 5\ H_20$$

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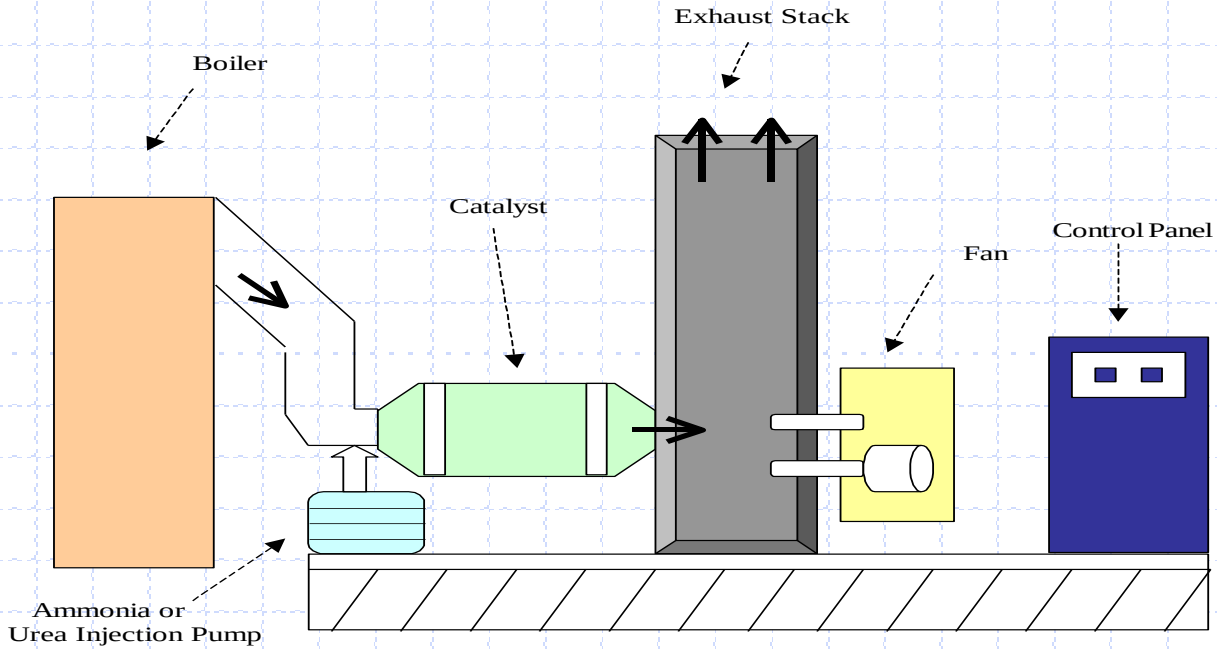
Skid Mounted SCR System



Skid Mounted Modular SCR Unit

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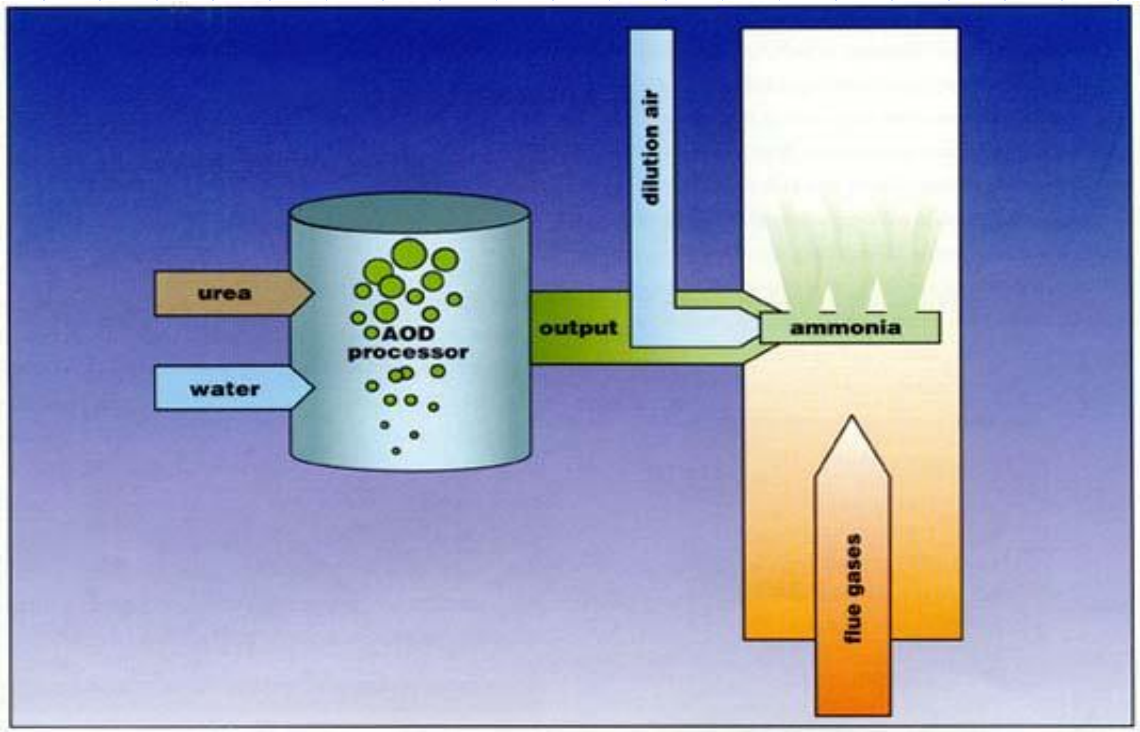
UREA Injection



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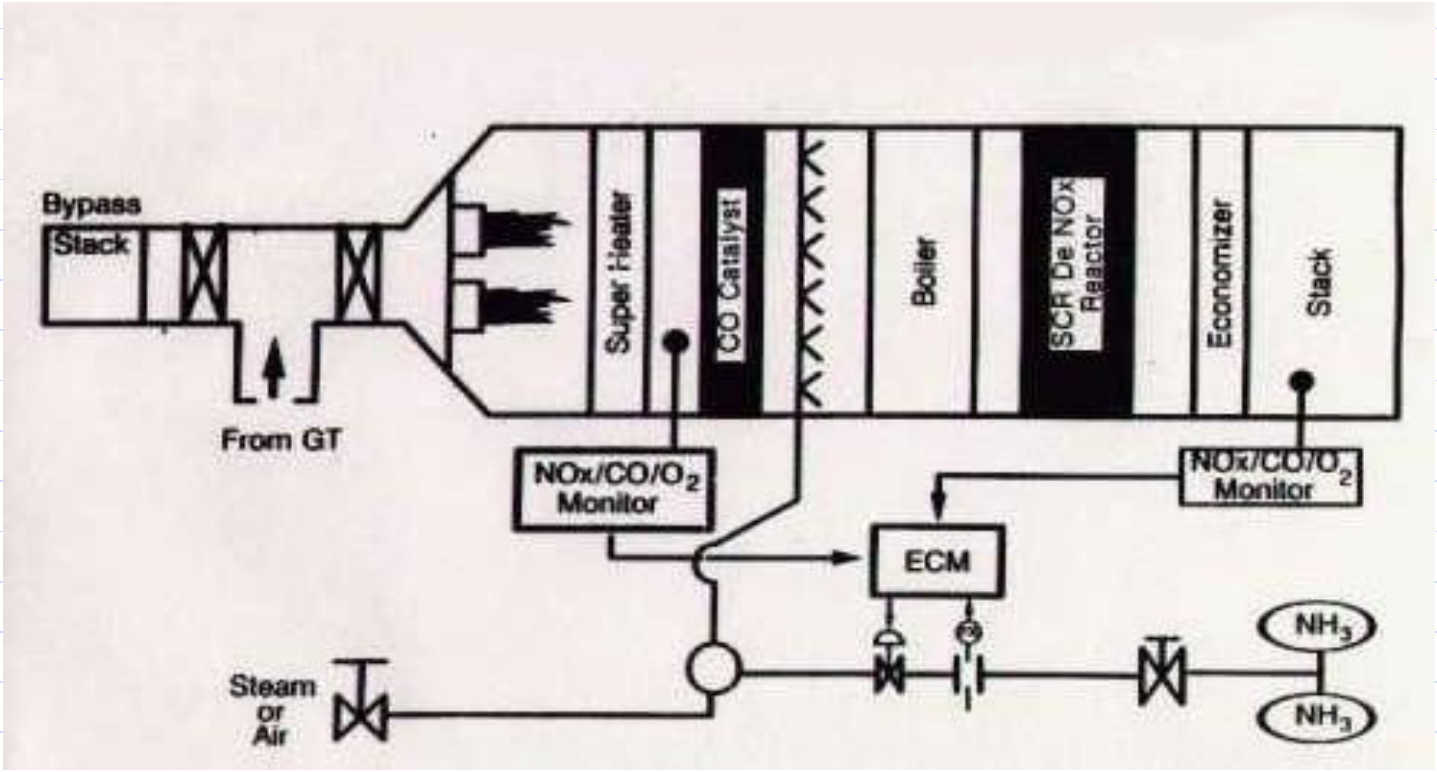
SCR & CO Catalyst in a HRSG



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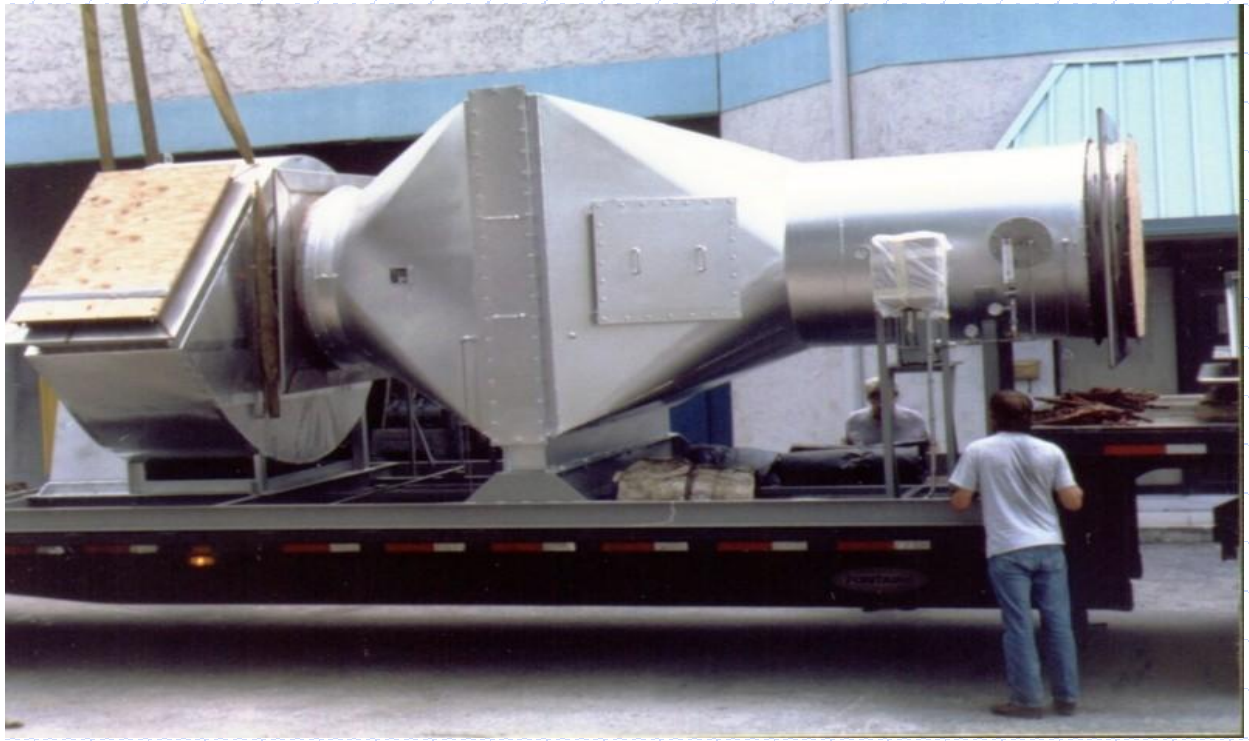
SCR for Furnace



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SCR for Gas Turbine

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Photo of a SCR System

SCR Systems were shop-tested prior to shipment

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SCR Cost Effectiveness Evaluation

Assume:

- Boiler H.P. = 600
- Burner BTU Rating = 30 MMBtu/Hr
- NOx emissions = 30 ppm
- NOx emission after SCR Control w/ Aqueous Ammonia Injection = 6 ppm

Calculation:

Daily NOx Emission Reduction:

0.036 lb MMBtu/hr x 30 MMBtu/hr x 24 hr/day x (1 – 6/30)

= 20.73 lbs/day

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SCR Cost Effectiveness Evaluation

- Assuming the facility operates 300 days/year

Calculation:

Annual NOx Emission Reduction**:**

20.73 lbs/day x 300 days/year = 6220 lbs/year

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SCR Cost Effectiveness Evaluation

- Estimated SCR Capital Cost = $200,000
- Estimated Installation Cost = $30,000
- Estimated Annual Operation & Maintenance Cost = $10,000

Assuming a 10 Year Life for the Control Equipment at 7% Interest Rate

Annualized Control Equipment Cost = $43,000

Value of NOx = $43,000 / 6,220 = $6.91 / lb

Environmental Compliance Workshop

Sierra Engineering Services

17752 Skypark Circle, Ste 210

Irvine, CA 92614

TEL: (949) 833-3455

FAX: (949) 833-2970

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Air Quality Facility Types

Title V

RECLAIM

Source Specific (Command & Control)

Air Quality Facility Types

Title V

RECLAIM

Source Specific (Command & Control)

SIERRA ENGINEERING SERVICES

Maintenance Requirements

1. Routine Equipment Inspection

(Daily, Weekly, Quarterly, Annual)

2. Source Test

(Annual, 3 years, 5 years)

3. Tune-up

(Semi-Annual, Annual)

SIERRA ENGINEERING SERVICES

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SIERRA ENGINEERING SERVICES

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SIERRA ENGINEERING SERVICES

Record Keeping

* Always remember to record Time, Date, Responsible personnel, Unit of Measurements, & AQMD Facility ID

1. Equipment Inspection

2. Material & Solvent Usages

3. Operating Parameters: Temp, Pressure….

3. Visible Emission

SIERRA ENGINEERING SERVICES

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Compliance Requirement: IC ENGINE

Applicable Rules	1110, 1110.1, 1110.2, Reg XIII
Usage Limit	Fuel Sulfur concentration Engine Operating Time
Maintenance	Engine Tune-Up
Monitoring	Oxygen Exhaust Concentration NOx & CO Concentration
Record Keeping	Date, Elapsed Time (Hours) of Operation

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SIERRA ENGINEERING SERVICES

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Compliance Requirement: TEXTILE PRINTING PRESS

Applicable Rules	1130, 1171, Reg XIII
Usage Limit	Ink Usage
Maintenance	Cleaning
Monitoring	Capture Efficiency VOC of Ink
Record Keeping	Daily VOC of Material

SIERRA ENGINEERING SERVICES

Compliance Requirement: TEXTILE PRINTING PRESS

Applicable Rules	1130, 1171, Reg XIII
Usage Limit	Ink Usage
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Monitoring	Capture Efficiency VOC of Ink
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Compliance Requirements: Wastewater Discharge

- Self Monitoring Report
- Sanitation District Ordinance Requirements
- Federal Pretreatment Requirements
- Annual Surcharge Fee Statements
- Flow Meter Calibration Requirements

Compliance Requirements: Hazardous Waste Disposal

- California State Waste Generator ID
- Preparation of Manifest for Haz. Waste Disposal
- Record Keeping of Disposal Records for 3 years

2012 AIR QUALITY WORKSHOP ON DIESEL & GAS FIRED EQUIPMENT

Presented by:

Mr. Saeed Ahdout

March 28th 2012

STATE RULES

Air Resources Board (CARB) Fleet Rules.

ARB Off-Road Equipment Rules.

ARB Rules On Portable Diesel Fired Power Generators.

LOCAL AGENCY RULES

SCAQMD Rule 1470, On Stationary Emergency Diesel Fired Emergency Generators.

SCAQMD Fleet Rules.

SCAQMD Rule 1472 (Proposed) On Facilities With Three Or More Diesel Fired Generators.

SCAQMD Rule 1110.2 On Diesel & Gas Fired Engines.

SCAQMD Rule 1191, On Light & Medium Duty Public Fleet Vehicles.

LOCAL AGENCY RULES (CONT'D)

SCAQMD Rule 1192, On On-Road Transit Buses.

SCAQMD Rule 1193 On Refuse Collection Vehicles.

SCAQMD Rule 1194 On Air Port Ground Access Vehicles.

SCAQMD Rule 1195 On On-Road School Buses.

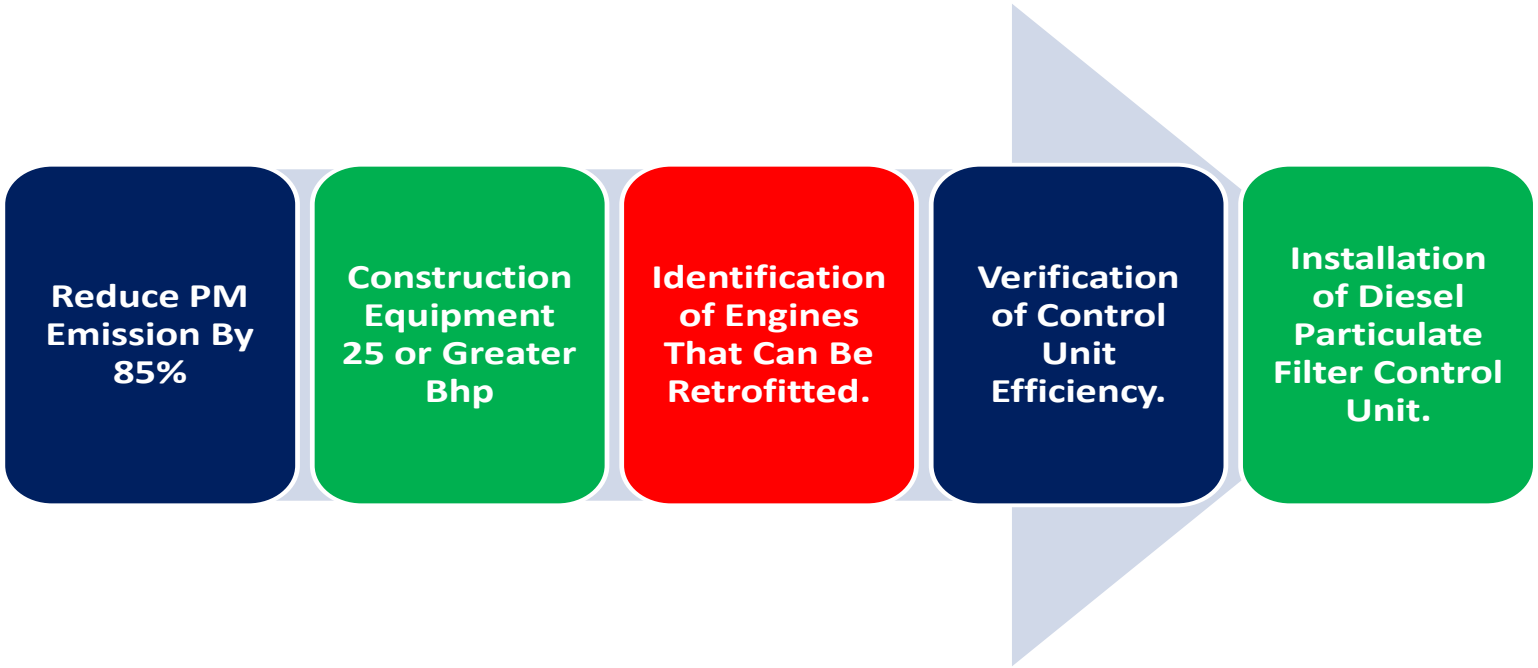
SCAQMD Rule 1196 On Heavy Duty Public Fleet Vehicles.

SCAQMD Rule 2449 On Nitron Oxide Reduction From Off Road Diesel Vehicles

Types Of Diesel Fired Equipment Subject To State Air Quality Rules:

- Cargo Handling Equipment at Ports & Rail Yards.
- Off-Road Construction Equipment.
- In Use Heavy Duty Vehicles, Trucks, & Buses.
- In Use Heavy Duty Public Utility Fleets.
- In Use Solid Waste Collection Vehicles.

DIESEL PARTICULATE EMISSION REDUCTION PLAN



IN USE OFF-ROAD CONSTRUCTION EQUIPMENT RULE

This Rule was passed by ARB On July 26, 2007, and requires reduction of Diesel Particulate Matter (PM) and Nitrogen Oxides (NOX) in Diesel Equipment used in Construction, Mining and Industrial Operations.

OFF-ROAD EQUIPMENT APPLICABLE PROVISION

Off-Road Diesel Engine BHP Greater Than 25

Types Of Off-Road Equipment Includes:

- -Loaders

- -Crawler Tractors

- -Skid Steers

- -Backhoes

- -Forklift

- -Air Port Ground Support Equipment

Example: Off-Road Equipment

Tier I Engines (100-172 BHP) Manufactured from 1997 to 2002.

State Certified Particulate Emission Rate: 0.6 gm/bhp-hr

Required Particulate Control Efficiency: 85%

Particulate Emission Rate After Retrofits: 0.6 gm/bhp-hr x (1-0.85) = 0.09 gm/bhp-hr

State Limit in 2011 (0.22 gm/bhp-hr)

In 2012, PM Limit Drops to 0.015 gm/bhp-hr.

The Offroad Retrofitted Tier I Equipment is Compliant Till end of 2011.

Example: Off-Road

Tier I Engine (175- 300 BHP)

State Certified Particulate Emission Rate: 0.4

PM Emissions After Retrofit: 0.06 gm/bhp-hr, Compliant till 2011. In 2012, The Limit Drops to 0.015 gm.bhp/hr.

Off-Road Equipment Between 25 to 74 bhp, Needs To Comply With PM Limit of 0.02 gm/bhp-hr by 2013.

Off-Road Equipment Between 175 to 750 bhp, Needs to Comply With PM Limit of 0.015 gm/bhp-hr (Tier IV) by 2011.

Off-Road Equipment Greater Than 750 BHP, Needs To Comply With Interim Tier IV PM Limits of 0.07 gm/bhp-hr

By 2011 and Tier IV PM Limit s of 0.03 gm/bhp-hr by 2015.

Diesel Truck & Bus Regulation- Section 2025

- Trucks of 13 tons weight or less need to meet section 2025(k) record-keeping requirements.
- Trucks of greater 13 tons must meet PM BACT & upgrade to a 2010 model year emission equivalent starting January 2015.
- Truck fleet operator's have the option to meet PM BACT compliance by retrofitting:

  * 2003-2004, 1993 & older engines in 2012.

  * 2005-2006, 1994-1999 model engines by 2013.

  * All engines by January 2014.

  * Fleet Owners choosing this option must comply with reporting & record-keeping requirement.

  *Any engine that meets PM BACT prior to Jan 1, 2014 does not have to be upgraded to a 2010 model year emissions equivalent till Jan 1, 2020.

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  *Any engine that meets PM BACT prior to Jan 1, 2014 does not have to be upgraded to a 2010 model year emissions equivalent till Jan 1, 2020.

Table 1: Compliance Schedule by Engine Model Year for Vehicles with a GVWR 26,000 lbs or less

Compliance Date as of January 1	Existing Engine Model Year	Requirements
2015	1995 & Older	2010 model year emission equivalent
2016	1996	
2017	1997	
2018	1998	
2019	1999	
2020	2003 & older	
2021	2004-2006	
2022	N/A	
2023	All engines	

Table 2: Compliance Schedule by Engine Model Year for Vehicles with GVWR greater than 26,000 lbs

Engine Model Year	Compliance Date Install PM Filter by	Compliance Date 2010 Engine by
1993 & older	N/A	January 1, 2015
1994 - 1995	N/A	January 1, 2016
1996 - 1999	January 1, 2012	January 1, 2020
2000 - 2004	January 1, 2013	January 1, 2021
2005 - 2006	January 1, 2014	January 1, 2022
2007 or newer	January 1, 2014 if now OEM equipped	January 1, 2023

Table 3: Phase-in Compliance Schedule for Vehicles with GVWR greater than 26,000 lbs

Compliance Date as of January 1	Percent of Fleet Complying with PM BACT
2012	30%
2013	60%
2014	90%
2015	90%
2016	100%
2020	All vehicles must comply with section 2025(g)

Table 4: Compliance Schedule for School Buses

Compliance Deadline as of January 1	Percent of Fleet Complying with PM BACT
2012	33%
2013	66%
2014	100%

PORTABLE DIESEL GEN REQUIREMENTS

Fleet Standard Compliance Date	Engines <175 hp (g/bhp-hr)	Engines 175 to 750 hp (g/bhp-hr)	Engines>750 hp (g/bhp-hr)
1/1/13	0.3	0.15	0.25
1/1/17	0.18	0.08	0.08
1/1/20	0.04	0.02	0.02

Routine Maintenance Inspection

Diesel Engine Inspection Prior To Filter Installation

Diesel Generator Retrofitted With A Particulate Filter

General Maintenance Requirements

- The Diesel Particulate Filter Clean-up Frequency is Dependent On The Use.
- An Annual Inspection and Clean-up is Recommended To Be Conducted By A Field Service Technician.
- Most Of The ARB Filters Require Removal Of the Unit & Offsite Clean-Out By A Diesel Particulate Thermal Regenerator.
- A Diesel Particulate Filter Thermal Regenerator Could Also Be Installed In The Maintenance Yard. Onsite Operators Need To Be Trained By The Filter Manufacturer.
- Estimated Cost For Furnishing & Installation of Thermal Regeneration Is Around 15 to 20 K.

Required Conditions For Proper Operation Of Diesel Particulate Filter:

- The application must have a duty cycle with an average temperature profile of greater than 300 degrees Celsius (572 degrees F) for at least 30 percent of the operating cycle.
- The engine is originally manufactured from model year 1996 through 2008.
- The engine must be in either the Tier 1, Tier 2 or Tier 3 emissions standard categories.
- The engine must not employ exhaust gas recirculation.
- The engine must be four-stroke
- The engine can be mechanically or electronically controlled.
- The engine can be turbocharged or naturally aspirated.
- The engine may or may not have a pre-existing original equipment manufacturer oxidation catalyst.
- The engine must not have a pre-existing diesel particulate filter from the original equipment manufacturer.
- The engine must be well maintained and not consume lubricating oil at a rate greater than that specified by the engine manufacturer.
- The engine must be operated on diesel fuel with a sulfur content of no more than 15 parts per million (ppm) by weight.
- Lubricating oil, or other oil, should not be mixed with the fuel.

RULE 1110.2

Concentration Limits Effective July 1, 2011		
NOx (ppmvd)[1]	VOC (ppmvd)[2]	CO (ppmvd)[1]
11	30	250

RULE 1110.2

Concentration Limits For Landfill and Digestor Gas-Fired Engines		
Nox (ppmvd)[1]	VOC (ppmvd)[2]	CO (ppmvd)[1]
Bhp ≥ 500: 36 x ECF[3] Bhp < 500: 45 x ECF[3]	Landfill Gas: 40 Digestor Gas: 250 x ECF[3]	2000

Concentration Limits Effective July 1, 2012		
Nox (ppmvd)[1]	VOC (ppmvd)[2]	CO (ppmvd)[1]
11	30	250

[1]Parts per million by volume, corrected to 15% oxygen on a dry basis and averaged over 15 minutes.

[2]Parts per million by volume, measured as carbon, corrected to 15% oxygen on a dry basis and averaged over the sampling time required by the test method.

[3]ECF is the efficiency correction factor.

RULE 1110.2

Emission Standards For New Electrical Generation Engines

Pollutant	Emission Standard (lbs/MW-hr)[1]
NOx	0.070
CO	0.20
VOC	1.10[2]

Rule 1146 Standard Compliance Limits and Schedule

Category	Limit	Submit Compliance Plan on or before	Submit Application for Permit to Construct on or before	Unit Shall be in Full Compliance on or before
Group I Units	5 ppm or 0.0062 lbs/10_6 Btu	-	January 1, 2012	January 1, 2013
Group II Units 75% or more of units (by heat input)	9 ppm or 0.011 lbs/10_6 Btu	January 1, 2010	January 1, 2011	January 1, 2012
Group II Units 100% of units (by heat input)	9 ppm or 0.011 lbs/10_6 Btu	January 1, 2010	January 1, 2013	January 1, 2014
Group III Units 75% or more of units (by heat input)	9 ppm or 0.011 lbs/10_6 Btu	January 1, 2011	January 1, 2012	January 1, 2013
Group III Units 100% of units (by heat input)	9 ppm or 0.011 lbs/10_6 Btu	January 1, 2011	January 1, 2014	January 1, 2015b

Group I Units: Boilers 75 MMBTU/Hr or greater
Group II Units: Boilers less than 75 MMBTU/Hr to 20 MMBTU/Hr
Group III Units: Boilers less than 20 MMBTU/Hr to 5 MMBTU/Hr

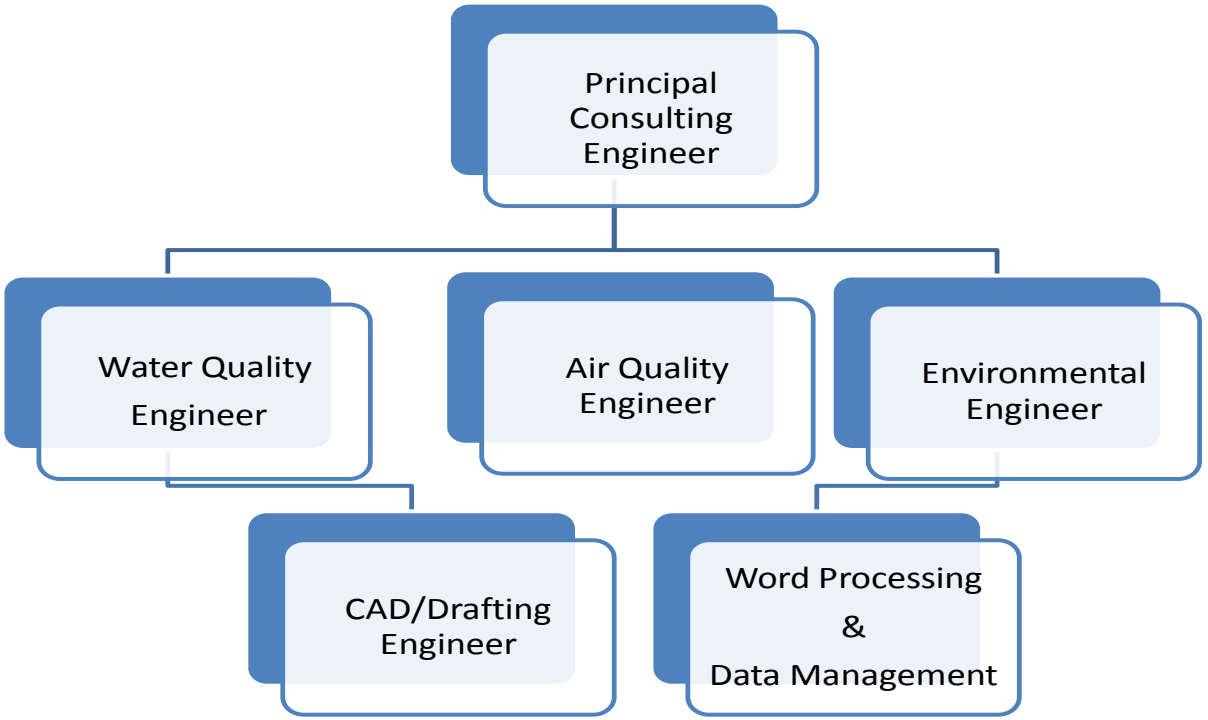
Rule 1146.1 NOx Limit

Category	Limit	Submit Application for Permit to Construct on or before	Unit Shall be in Full Compliance on or before
Any Units Fired on Landfill Gas	25 ppm	January 1, 2014	January 1, 2015
Any Units Fired on Digester Gas	15 ppm	January 1, 2014	January 1, 2015
Atmospheric Units	12 ppm or 0.015 lbs/10_6 Btu	January 1, 2013	January 1, 2014
Any Units Fired on Natural Gas, Excluding Units Located at Schools and Universities, Atmospheric Units, and Thermal Fluid Heaters	9 ppm or 0.11 lbs/10_6 Btu	January 1, 2011	January 1, 2012
Any Units Fired on Natural Gas Located at Schools and Universities, Excluding Atmospheric Units, and Thermal Fluid Heaters	9 ppm or 0.11 lbs/10_6 Btu	January 1, 2013	January 1, 2014

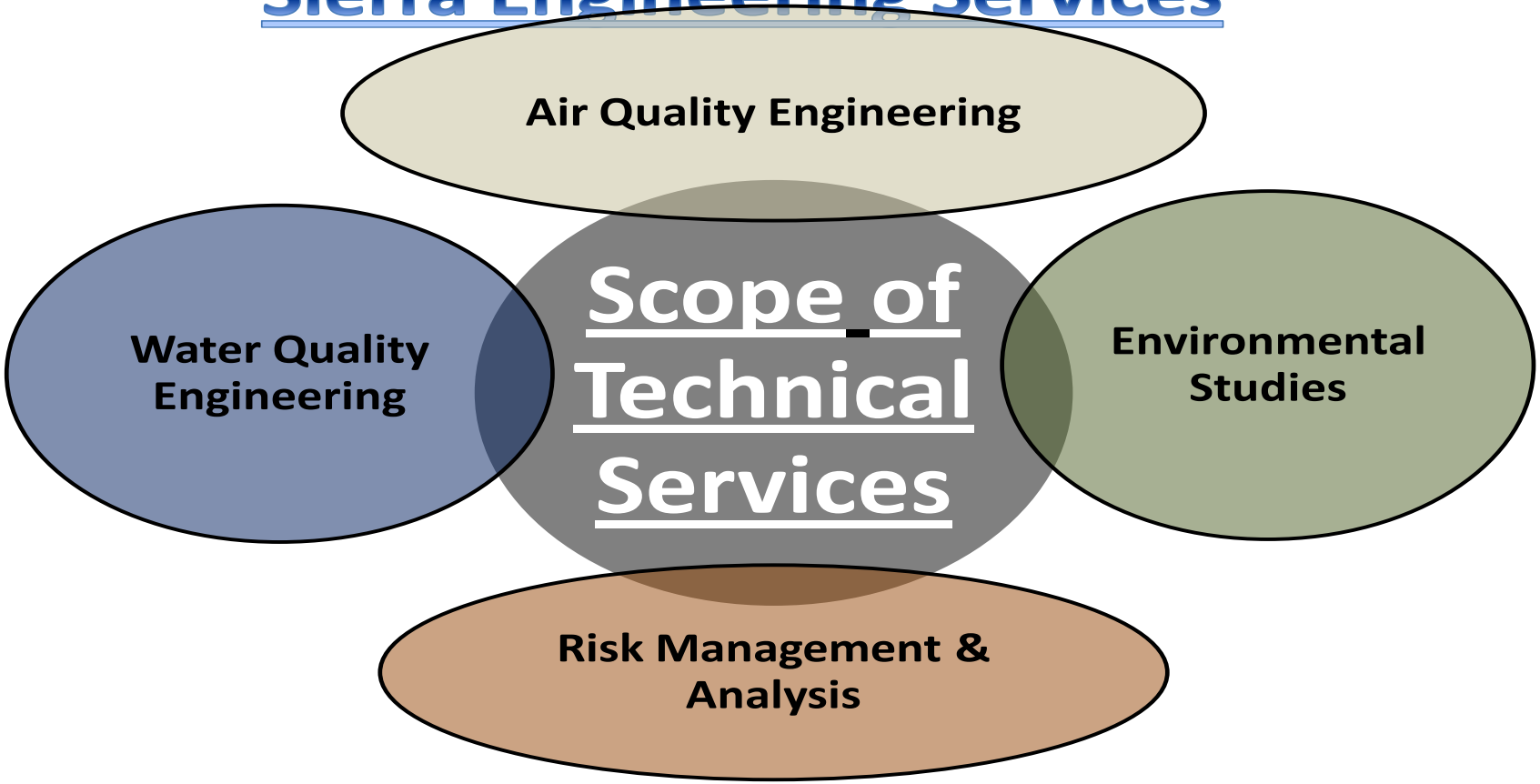
Rule 1146.2 NOx Limit

- On or after January 1, 2006, no person shall operate in the District any unit more than 15 years old, based on the original date of manufacture as specified in paragraph (c)(6), with a rated heat input capacity greater than 1,000,000 Btu per hour but less than or equal to 2,000,000 Btu per hour and manufactured on or after January 1, 1992, which does not meet the emissions limits of 30 PPM of NOx.

Organization Chart



Sierra Engineering Services



REFERENCES

1. South Coast Air Quality Management District, Rules and Regulations, Diamond Bar, CA.

2. Pacific Textile News, Los Angeles, CA.

3. Boilers Manufacturer Specifications.

4. Los Angeles County Sanitation District, Regulations, Whittier, CA.

5. South Coast Air Quality Management District Best Available Control Technologies Guidelines.

6. Manufacturer's Information on Industrial Wastewater Pre-Treatment.

7. Manufacturer and Specifications on Air Pollution control Equipment, Selective Catalytic Reduction.