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INTRODUCTION TO ENVIRONMENTAL LAW FOR PULP AND PAPER MANAGERS

by Eugene T. Holmes

Serving as the text for TAPPI's "Environmental Law for Pulp and Paper Managers" seminar taught by the author, this book briefly acquaints you with the American legal system and the development of the field of environmental law.

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- **Environmental Protection Agency**
- **National Environmental Policy Act**
- **Clean Air Act and EPA and state air regulations**
- **Clean Water Act**
- **Safe Drinking Water Act**
- **RCRA**
- **Superfund**
- **Pesticides (FIFRA)**
- **Toxic Substances Control Act (TSCA)**

PLUS—All EPA water regulations for pulp, paper, and related sources have been reproduced in a handy appendix.

The author, Eugene T. Holmes, was a process engineer for Union Camp Corporation and a member of the legal staff of EPA before entering private law practice in Atlanta in 1974. Approved by the State Bar of Georgia to designate practice in environmental and natural resources law, he has authored articles on environmental and energy law for the *Natural Resources Lawyer* of the American Bar Assciation, *Georgia State Bar Journal*, and *Mississippi Law Journal*. He is also the author of a regular column on environmental law in a monthly industry publication. He has lectured for AIChE, EPRI, and the Universities of Georgia, Kentucky, Missisippi, and Texas, as well as teaching regular seminars for ACS and *Coal Outlook*.

Introduction to Environmental Law for Pulp and Paper Managers

By Eugene T. Holmes

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PSD PERMITTING FOR A FUEL CONVERSION AT A NORTHEASTERN PAPER MILL

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ABSTRACT

Many industrial facilities are faced with finding an inexpensive and plentiful source of fuel to burn in the 1980s and beyond. Because of rising prices and the potential scarcity of oil and natural gas, the paper industry is turning to coal and biomass as alternative fuels. A boiler designed to burn any combination of coal, biomass, and perhaps oil may be added to an existing facility to provide additional steam capacity or may replace existing inefficient units. This article focuses on the actual experience of a northeastern paper company in applying for and procuring the necessary permits associated with a new multi-fueled boiler. The underlying factors contributing to the decision to fire coal and biomass at this paper mill are also delineated herein.

INTRODUCTION

Escalating prices and the potential scarcity of oil and natural gas are causing the paper industry to consider burning coal and/or wood as alternative fuels at existing mills. Prior to initiating such conversions, however, a company must evaluate numerous environmental regulations and determine the requirements for procuring permits. In general, the key laws affecting a fuel conversion are the Clean Air Act (CAA), the Resource Conservation and Recovery Act (RCRA), and the Clean Water Act. These laws have generated many complex regulations that apply to various aspects of coal and wood utilization as shown in Table 1. In this paper, regulatory issues pursuant to the CAA and their applicability to a fuel conversion at the S.D. Warren Company are discussed.

Table 1 Principal environmental laws and regulations affecting major fuel conversions

Legislation	Regulations	Pollutant Sources
Clean Air Act	New Source Performance Standards	Particulates, SO_2 and NO_x from boilers.
	Prevention of Significant Deterioration Regulations	Fugitive dust from coal and biomass handling and all regulated pollutants from boilers in attainment areas.
	Nonattainment Area Rules	Fugitive dust and criteria pollutants from boilers in nonattainment areas.
Resource Conservation and Recovery Act	RCRA Regulations	Leachate from ash in landfills or ponds.
Clear Water Act	National Pollutant Discharge Elimination System Rules	Coal and biomass pile runoff.

S.D. Warren, a division of Scott Paper Company, is located in Westbrook, Maine, approximately 5 miles northwest of Portland. The mill is an integrated pulp- and paper-making facility producing over 600 tons per day of printing, publishing, and specialty paper products. The mill operates 24 hours per day and is heavily dependent on the reliability of its power boilers for economical and efficient operation. Prior to February 1982, process steam and power for the mill was provided by four oil-fired boilers and an oil- and bark-fired boiler. The five boilers have a total heat input rate of about 981 million Btu per hour (MMBtu/hr) at maximum continuous ratings and fire No. 6 fuel oil with a maximum sulfur content of 2.5%. Additional steam is also provided by the recovery boiler.

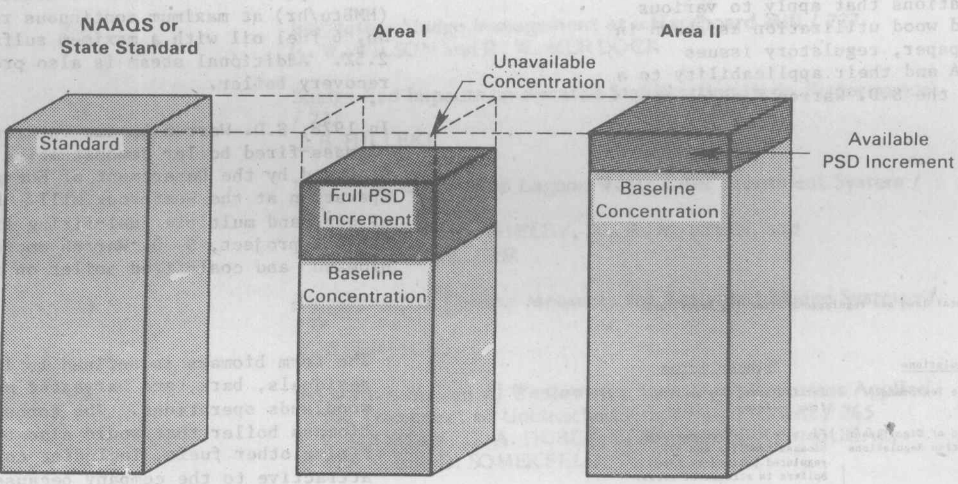
In 1978, S.D. Warren became interested in a biomass-fired boiler demonstration project proposed by the Department of Energy (DOE) for operation at the Westbrook mill. However, because of size and multiple fuel-firing limitations on the DOE project, S. D. Warren decided to build a biomass- and coal-fired boiler on its own.

The term biomass is defined to include sawmill residuals, bark, and harvested material from woodlands operations. The concept of adding a biomass boiler that would also be capable of firing other fuels, including coal and oil, was attractive to the company because:

- the existing power boilers would be in need of replacement in the 1980s;
- the cost of fuel oil in New England was becoming exorbitant;
- sources of biomass were available; and
- if the cost of biomass were to become prohibitive, the company would have the flexibility of burning coal and oil in combination with the biomass or independently.

The proposed biomass boiler would be sized large enough so that it could replace the five existing power boilers. Although S.D. Warren will continue to license the existing boilers, it is unlikely that they would be used except as back-up to the biomass boiler. For the first three years of operation, the proposed boiler would generally be fired with 50% biomass and 50% coal. Thereafter, the ratio of wood to coal would approach 75% to 25%. Oil would be fired only as supplementary fuel, during start-up and emergency conditions. The boiler would also have the capability of firing sludge and rubber tire chips up to a maximum of about 15% of the total heat input. The proposed unit would have a maximum continuous rating of 650,000 pounds of steam per hour (lb/hr) at 1,300 pounds per square inch for the optimum fuel firing configuration. This would require a maximum heat input rate to the boiler, firing 75% biomass and 25% coal, of 997 MMBtu/hr. Biomass and coal receiving, handling, and storage facilities would also be an integral part of the proposed project.

After S.D. Warren decided to proceed with the DOE demonstration project, it was necessary to obtain the pertinent environmental permits prior to construction of the boiler. Because emissions associated with the biomass boiler project would be major (exceeding 100 tons per year) for SO_2, particulate matter, NO_2, and CO and the site location was classified as attainment for these pollutants, a PSD permit was required.



The drawing illustrates the concept of PSD increments. In Area I, baseline levels plus the full PSD increments are below standards. In Area II, baseline levels are so high that only a portion of the PSD increments is available.

Figure 1 PSD increments

THE PSD PERMIT APPLICATION

In the fall of 1979, preparation of the PSD permit application for the proposed biomass boiler project began. The fact that the federal PSD regulations were undergoing considerable modification at that time had no bearing on the permit because the State of Maine had been granted administrative and enforcement authority over its own PSD program by the U.S. Environmental Protection Agency (U.S. EPA). As with the federal program, the basic components of a PSD application in Maine are:

- a Best Practical Treatment (BPT) analysis to reduce emissions to the lowest possible level in light of the state of technology, available alternatives, and economic feasibility; and
- an air quality impact analysis to ensure compliance with all ambient air quality increments and standards and to evaluate projected air quality impacts on soils, vegetation, and visibility.

For new major sources locating in attainment areas, BPT is equivalent to the federal definition of Best Available Control Technology (BACT).

In many respects, the Maine PSD program is more restrictive than the U.S. EPA regulations. For instance, the Maine Ambient Air Quality Standards

(MAAQS) for short-term standards are never to be exceeded, whereas the corresponding National Ambient Air Quality Standards (NAAQS) can be exceeded once per year. Furthermore, the MAAQS for SO_2 are substantially lower than the NAAQS. In addition to demonstrating compliance with the ambient standards, a PSD applicant must also comply with specified increments for SO_2 and TSP. PSD increments represent the maximum allowable increases in pollutant concentrations over baseline levels and are bounded by the NAAQS or state standards as shown in Figure 1.

The MAAQS and Class II PSD increments applicable to the S.D. Warren PSD permit application are shown in Table 2. It should be noted that in Maine, a particular applicant cannot consume more than 75% of the short-term increment and approximately 19% of the annual average increment. Under the federal program, an applicant can consume up to 100% of the available increment.

Table 2 MAAQS and Class II PSD increments ($\mu g/m^3$)

Pollutant	Averaging Period	MAAQS	PSD Increment
SO_2*	3-Hour	1150	512
	24-Hour	230	91
	Annual	57	20
TSP+	24-Hour	150	37
	Annual	60	19
NO_2	Annual	100	**
CO	1-Hour	40,000	**
	8-Hour	10,000	**

*Corresponding NAAQS in $\mu g/m^3$ are:
3-Hour 1,300
24-Hour 365
Annual 80

**Not applicable.

+Annual average for TSP based on geometric mean; other pollutants based on arithmetic mean.

BACT ASSESSMENT

The basic control technology requirement of the PSD rules in Maine is application of BACT. For major modifications such as the biomass boiler, BACT is defined as an emission limitation based on the maximum degree of reduction of each pollutant taking into consideration "energy, environmental, and economic impacts." At a minimum, BACT must comply with a set of federally promulgated emission standards known as the New Source Performance Standards (NSPS) and any applicable standard issued by the State of Maine.

The BACT requirements are intended to ensure that the control systems included in the design of a proposed facility reflect the latest in control techniques used in a particular industry, allow for future growth in the vicinity of that facility, and take into consideration ambient air quality. The PSD permit application for the proposed boiler thus included an evaluation of the air pollution control technologies included in the design of the facility. Alternative particulate control devices, including electrostatic precipitators (ESPs), baghouses, wet scrubbers, and gravel bed scrubbers, were assessed on the basis of technical feasibility and demonstrated performance levels. Control systems for SO_2, which consisted of alternative coal pretreatment techniques, combustion processes, and flue gas desulfurization (FGD) systems, were also evaluated in terms of their feasibility and performance as well as economics. These and other control technologies were intended to demonstrate that the proposed systems were indeed BACT for the proposed boiler. In addition, alternative fugitive dust suppression methods and control devices for the coal and biomass handling systems were evaluated.

As stated in the Maine regulations, emissions resulting from a source after BACT has been applied must comply with NSPS and state emission standards. The NSPS for fossil-fuel-fired steam generators limit particulate, sulfur dioxide, and

Table 3 New source performance standards and control technologies assessed for the biomass boiler

Pollutant	Fuel Configuration	Current NSPS* (lb/MMBtu)	Control Technologies Evaluated
Sulfur dioxide	Coal and biomass	1.2	Wet FGD systems (lime,
	Oil and biomass	0.8	limestone, dual alkali, etc.)
			Physical coal cleaning
			Chemical coal cleaning
			Solvent refined coal
			Fluidized bed combustion
			Low-sulfur coals
Particulates	Coal or oil and biomass	0.1	Fabric filters
			Electrostatic precipitators
			Wet scrubbers
			Dry scrubbers
			Mechanical collectors
Nitrogen oxides	Coal and biomass	0.7	Combustion modification
	Oil and biomass	0.3	
	Gas and biomass	0.2	NO_x tail-gas removal

*For boilers with a heat input rate greater than 250 MMBtu/hr.

nitrogen oxide emissions from boilers firing fossil fuels and/or biomass. The original NSPS for steam generators with a heat input greater than 250 MMBtu/hr derived from fossil fuel were promulgated in December 1971 and subsequently revised to permit heat derived from wood to be considered in determinations of compliance. The industrial boiler standards (yet to be proposed) were then scheduled to be proposed in 1980. Until these standards are proposed, the 1971 NSPS still apply to the proposed biomass boiler. Table 3 delineates the NSPS and alternate control strategies evaluated for the biomass boiler.

Particular emission limitations or control technology requirements adopted by Maine following submittal of S.D. Warren's application were more stringent than those required by the NSPS. The state rules imposed a more stringent particulate standard of 0.08 lb//MMBtu for all firing configurations. At the time of the permit application, the sulfur content of coal or oil used in Westbrook area was not to exceed 1.33 lb/MMBtu (equivalent to about 1.7% sulfur coal or 2.5% sulfur oil) regardless of that required under federal rules. Furthermore, the state published guidelines defining BACT for coal handling and storage facilities after the application was submitted.

The S.D. Warren PSD permit application was approved by the Maine DEP in the spring of 1981. In approving the permit, the state agency made the following BACT determinations:

- particulate emissions will be controlled by means of mechanical collector and electrostatic precipitator (as proposed) to a level of 0.08 lb/MMBtu;
- NO_x emissions will be controlled by means of combustion modifications (as proposed) to the levels of 0.7 lb/MMBtu firing coal and 0.3 lb/MMBtu firing oil;
- SO_2 emissions will be minimized by firing low-sulfur coal or oil--the level to be a function of the coal-to-biomass ratio as shown in Figure 2; and
- fugitive dust from the coal and biomass handling and storage facilities will be minimized through enclosure and control handling equipment.

The NO_x emission limitation was consistent with NSPS, whereas the particulate emission limitation followed state regulations (which are more stringent than NSPS). The SO_2 restrictions are more stringent than either the federal or state

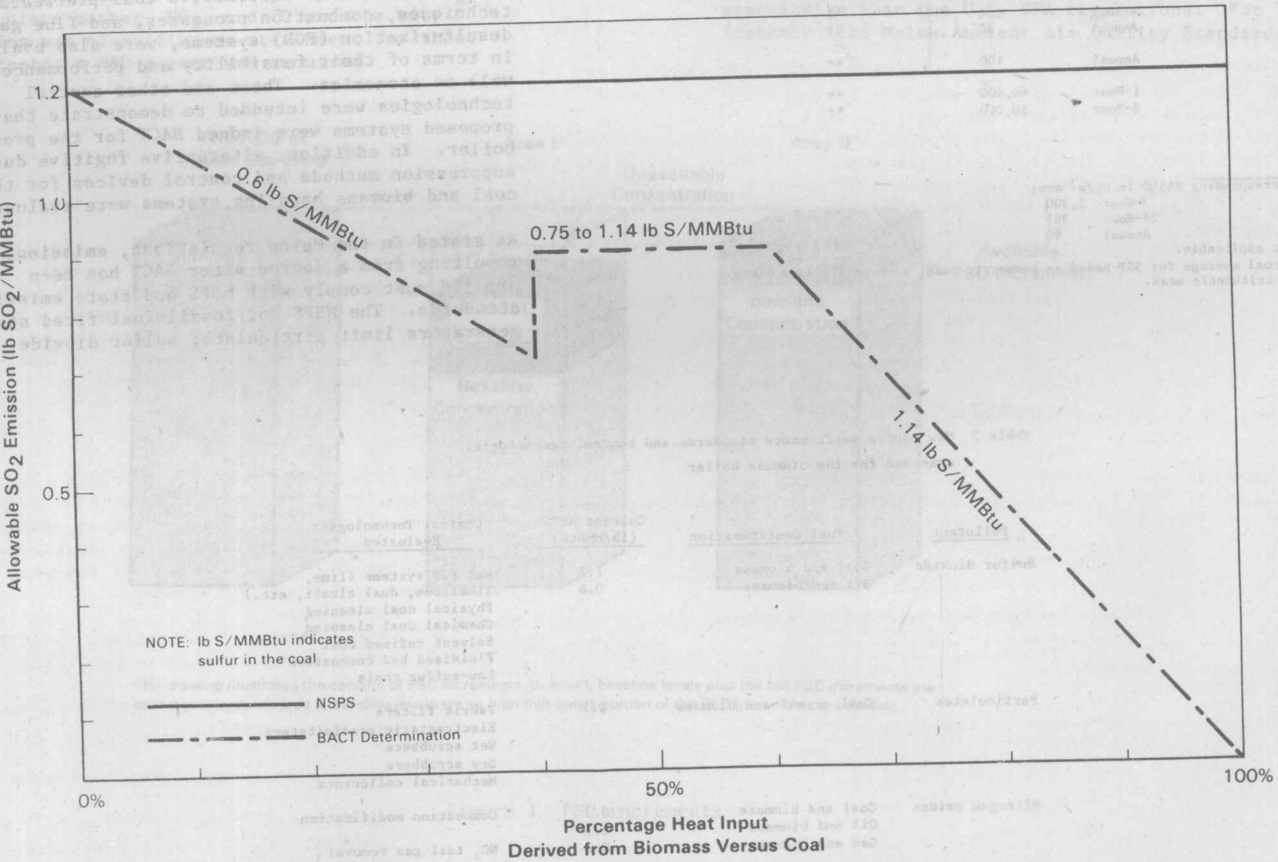


Figure 2 Applicable SO_2 standards and BACT determination for the proposed biomass boiler

requirements and were intended to encourage the highest utilization of biomass as fuel.

AIR QUALITY IMPACT ANALYSIS

The air quality impact analysis used to define baseline concentrations and demonstrate compliance with standards was based on worst-case and sequential dispersion modeling in addition to ambient measurement data. The Maine regulations define baseline concentrations as ambient air quality as of August 7, 1977 and as the level from which increment consumption is to be measured. At the time of the S.D. Warren permit application, substantial monitoring data were available in the Westbrook area; however, the locations of the sites did not generally correspond to the maximum impact areas of the existing mill. Consequently, the ambient measurements were used in combination with dispersion modeling of existing mill sources and a major background source to define total baseline concentrations and establish available increment levels. The monitoring data used in the PSD study were representative of background concentrations and did not reflect periods of existing mill impact.

Dispersion modeling was also used to predict pollutant concentrations attributable to the biomass boiler project. In general, several EPA-recommended guideline models were used in support of the PSD application.[1] Specifically, the screening models PTMAX and Valley were used to simulate emissions from the biomass boiler for four firing configurations, each at 100%, 75%, and 50% of full load. The results of this worst-case analysis were used to define the six following load/firing configurations that would require more refined analysis using the CRSTER model: 100% coal at 100%, 75%, and 50% loads; 75% biomass/25% coal at 100% and 75% loads; and 100% oil at 50% load.

The CRSTER model was run for the six proposed biomass boiler load/firing configurations and existing mill sources in areas of gently rolling terrain using a five year sequential meteorological data base. Valley was also used to identify maximum concentrations in areas where the terrain exceeded the mill stack heights. Techniques recommended by Huber and Snyder were applied to assess the aerodynamic effects of building downwash on the existing facilities.[2] Downwash analyses were not performed for the biomass boiler, since the stack was proposed to be at Good Engineering Practice height. Finally, the PAL model was run to simulate fugitive emissions associated with existing sources such as the wood chip pile, lime, and starch and clay handling activities as well as the proposed fugitive emissions attributable to coal/biomass storage and handling. This extensive set of modeling results was then evaluated to identify maximum expected pollutant impacts for comparison with the MAAQS and PSD increments.

For NO_2 and CO, maximum total concentrations were predicted to be substantially below the MAAQS shown in Table 2. SO_2 concentrations were also below the MAAQS and available increment levels, although baseline levels were near the standard on the potentially sensitive Portland Peninsula.

For TSP, however, 24-hour average baseline levels in the near vicinity of the mill were close to the ambient standard. Consequently, the proposed project was limited to an insignificant impact or 5 $\mu g/m^3$, 24-hour average. Because of the conservative nature of acceptable regulatory techniques for estimating fugitive emissions and predicting resultant concentrations, the biomass boiler project was initially unable to meet the insignificant threshold level. In order to attain compliance on the basis of modeling results, additional control measures such as enclosing the biomass storage pile and limiting the throughput to the potential coal storage pile were mandated.

To further ensure that standards would be met, retrofitting measures on existing sources of fugitive emissions, such as street sweeping in the vicinity of the mill, repairing seals on the starch silo, and refurbishing the dust collector on the lime storage silo, were also required by the state. Finally, in order to closely track ambient concentrations, the state required that S. D. Warren install and operate a TSP monitoring network to consist of up to eight sites.

Once compliance with standards and increments was demonstrated for NO_2, CO, SO_2, and TSP, it was concluded that there would be no adverse impacts on soils, vegetation, and visibility.

CONCLUSION

Environmental permitting considerations for paper mills contemplating fuel conversions are challenging, and associated projects require long-range planning. Often, compromises must be made in order to comply with standards. For S.D. Warren, the PSD permit was costly and time-consuming.

The biomass boiler project was initially contemplated in the fall of 1978, and PSD permitting efforts began in the fall of 1979. Preparation of the application, agency review, and negotiations took place over an 18-month period, and the application was finally approved in the spring of 1981. The biomass boiler at the S. D. Warren Westbrook facility was ultimately scheduled for operation in February 1982.

LITERATURE CITED

1. U.S. Environmental Protection Agency, Guideline on Air Quality Modeling. Research Triangle Park, NC (1978).

2. A. Huber and A. Snyder, Building Wake Effects on Short Stack Effluents. Preprints of the American Meteorological Society Third Symposium on Atmospheric Turbulence, Diffusion and Air Quality. Raleigh, NC (1976).

A TAPPI HOME STUDY COURSE ON CASSETTE TAPES

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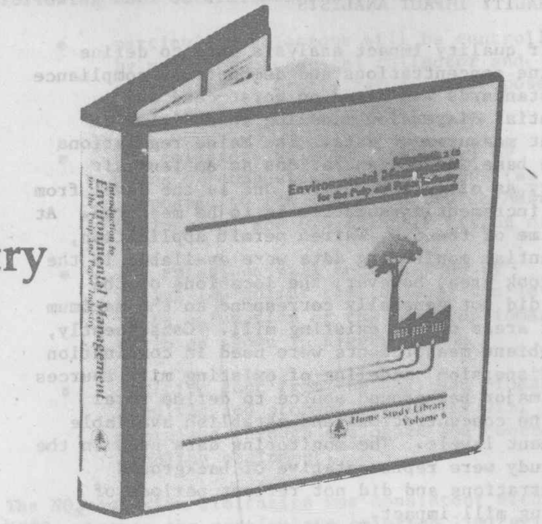

Prepared by Dr. Allen M. Springer
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The course was developed by Allen M. Springer of the Department of Paper Science and Engineering of Miami University in Oxford, OH. Narration was done by William Sanders, executive director of the Georgia Association of Broadcasters.

Those who wish to refresh or add to their knowledge of pulping and papermaking technology for greater understanding of some sections of this course on environmental management are advised to study the TAPPI Home Study Library volumes on *Introduction to Papermaking Technology* and *Introduction to Pulping Technology.*

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"SUMMARY OF OPERATING EXPERIENCE AND PERFORMANCE DATA ON SEVERAL MULTIPLE FUEL FIRED POWER BOILER PRECIPITATORS"

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ABSTRACT

In the past several years, the trend in the pulp and paper industry on new power boilers has been toward the capability of firing a variety of fuels. The use of coal, wood waste, oil, gas and sludge, either individually or in combination, has become the design criteria for the boiler as well as the air pollution control system. This poses unique design considerations. This paper presents the experience derived from several of these multiple fuel fired installations. Design versus actual operating conditions are presented as well as an indication of the problems experienced.

Recent years have seen a substantial amount of activity in the area of power boilers in the paper industry. This has, of course, resulted from the necessity to combat the soaring cost of energy by installing large, efficient boilers capable of firing a multiplicity of fuels. The use of oil and gas has given way, in large measure, to the economically more attractive use of coal and wood waste as the primary fuel sources. It is obvious that the use of various fuels imposes more complex operating and control procedures than a single source would. Fuel handling, method of firing, excess air requirements and a host of other variables must be taken into account. The same considerations apply to the air pollution control equipment. There are significant variations in gas volume, temperature, and particulate loading between say, 100% wood waste firing and 100% coal firing. In addition, if the coal has a low sulphur and sodium content, the particulate may be "high resistivity" which is not the case with bark ash. This imposes two substantially different operating requirements on the electrostatic precipitator and it must be designed with this in mind. The data below shows the principal areas of difference and gives a general indication of the levels of variation to be expected:

	Wood/Coal Wood/Oil	Coal	Wood
Volume, acfm	535,000	360,000	420,000
Moisture	8-20	3-8	10-20
Inlet, gr/acf	2.18	2.75	2.13
Resistivity ohm/cm	10^5-10^{10}	10^9-10^{13}	10^5-10^7

Our first installation on a mixed fuel fired boiler went into service in 1979. Since that time, we have placed seven (7) additional units on stream. We will undertake a brief description and case history of several of the operating units. Figure 1 depicts a typical electrostatic precipitator of the type which would be used on a wood waste/coal fired boiler.

St. Regis Paper Company, Monticello, Mississippi

Boiler Rating:	600,000 lbs/hr. steam
Fuel:	Bark @ 120,000 lbs/hr. Gas @ 12,385 lbs/hr., or Oil @ 14,516 lbs/hr.
Mechanical Collector:	Existing, rated at 70% efficiency
Precipitator Design Conditions:	Volume - 400,000 acfm Loading - 0.784 gr/acf Outlet - 0.019 gr/acf Efficiency - 97.6%
Precipitator Data:	2 chambers, 4 fields in each chamber, 8 power supplies, trough hoppers, screw conveyor dust removal.
Performance Data:	Volume - 280,000 acfm Loading - 0.204 gr/acf Outlet - 0.0054 gr/acf Efficiency - 97.35%
Experience:	No maintenance problems, serious fire due to boiler upset.

Electrostatic Precipitator (With Rigid Discharge Electrodes and Penthouse)

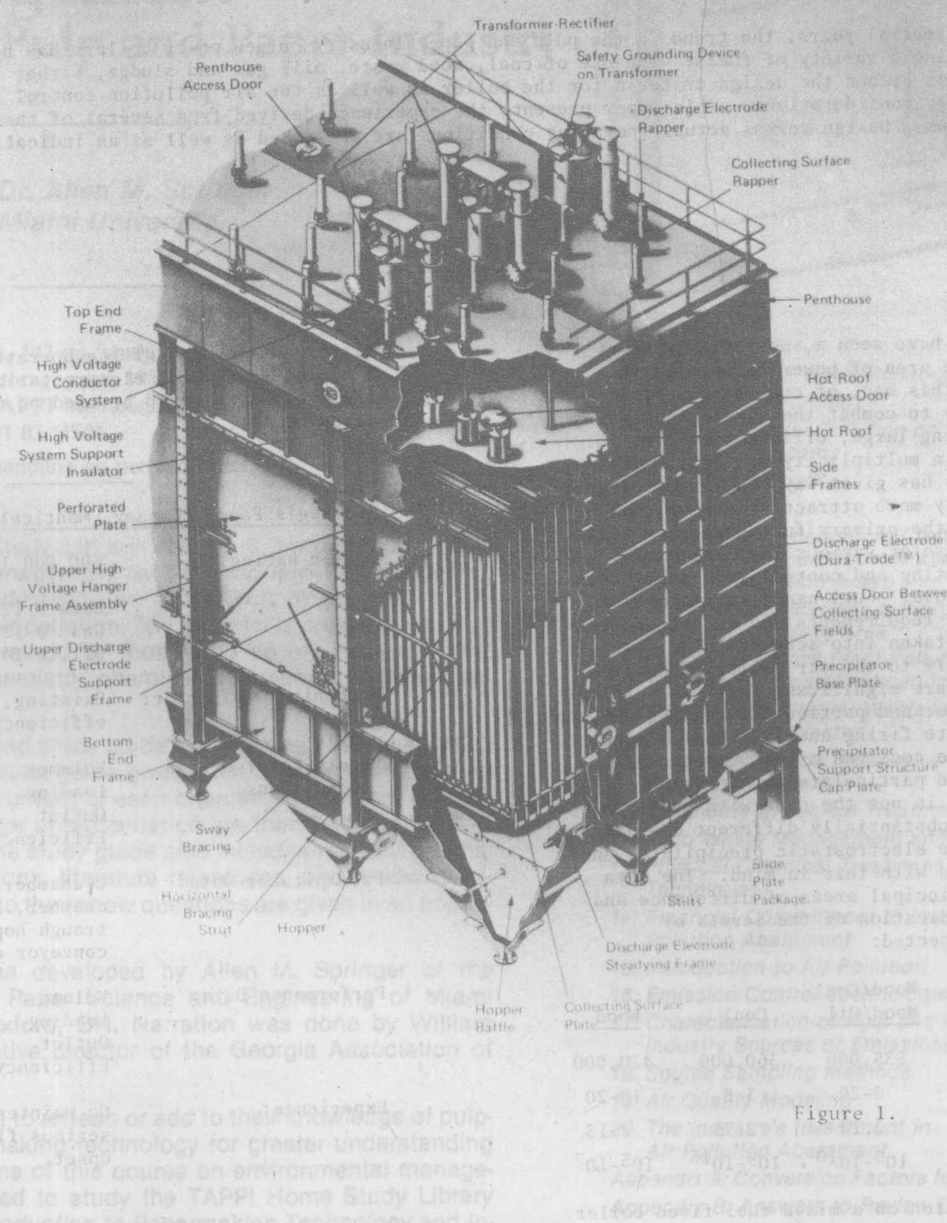

Figure 1.

Union Camp Corporation, Montgomery, Alabama

Boiler Rating: 350,000 lbs/hr steam

Fuel: Coal @ 31,303 lbs/hr., or wood waste @ 125,619 lbs/hr. or oil @ 8400 lbs/hr. + wood waste @ 80,000 lbs/hr.

Mechanical Collector: 85% efficiency of 3.98 gr/acf

Precipitator Design Conditions: Volume - 124-224,000 acfm; Loading - 0.597 gr/acf; Outlet - 0.0123 gr/acf; Efficiency - 97.95%

Precipitator Data: 2 chambers, 4 fields in each chamber, 8 power supplies, pyramidal hoppers, pneumatic dust removal.

Performance Data: Volume - 284,000 acfm; Loading - 0.381 gr/acf; Outlet - 0.0035 gr/acf; Efficiency - 99.1%

Experience: Dust removal problems, hopper pluggage, hopper fires

Potlatch Corporation, Lewiston, Idaho

Boiler Rating: 550,000 lbs/hr. steam

Fuel: Hog fuel and gas

Mechanical Collector: 50% of 1.97 gr/acf

Precipitator Design Conditions: Volume - 415,000 acfm; Loading - 0.986 gr/acf; Outlet - 0.00493; Efficiency - 99.5

Precipitator Data: 2 chambers, 4 fields in each chamber, 8 power supplies, pyramidal hoppers, pneumatic dust removal

Performance Data: Volume - 368,000 acfm; Loading - 0.073 gr/acf; Outlet - 0.002; Efficiency - 97.2%; Opacity - 3%

Experience: Considerable dust removal system problems, localized minor fire damage.

Great Northern Paper, Millinocket, Maine

Boiler Rating: 300,000 lbs/hr. steam

Fuel: Bark, wood waste, sludge and oil

Mechanical Collector: 70% of 2.617 gr/acf

Precipitator Design Conditions: Volume - 230,000 acf; Loading - 0.785 gr/acf; Outlet - 0.0098 gr/acf; Efficiency - 98.75%

Precipitator Data: 1 chamber, 4 fields, 8 power supplies, trough hoppers, screw conveyor dust removal.

Performance Data: Volume - 215,745 acfm; Loading - not run; Outlet - 0.00274 gr/acf; Efficiency - -------

Experience: Dust removal system problems.

Several other installations which were placed in service in the first quarter of 1982 are described below. Actual performance and operating data on these is not yet available.

Chesapeake Corporation, West Point, Virginia

Boiler Rating: 420,000 lbs/hr. steam

Fuel: Wood waste, sludge and future coal

Mechanical Collector: 70% of 4.56 gr/acf

Precipitator Design Conditions: Volume - 225-351,000 acfm; Loading -1.37 gr/acf; Outlet -0.02 gr/acf; Efficiency -98.57

Precipitator Data: 2 chambers, 3 fields, 6 power supplies, pyramidal hoppers, pneumatic dust removal.

S. D. Warren Company, Westbrook, Maine

Boiler Rating: 650,000 lbs/hr.

Fuel: Wood waste, coal, oil

Mechanical Collector: Yes

Precipitator Design Conditions: Volume - 360-535,000 acfm; Loading - 2.75 gr/acf; Outlet - 0.01; Efficiency - 99.63%

Precipitator Data: 2 chambers, 5 fields, 10 power supplies, trough hoppers, mechanical (chain) type conveyors for dust removal.

Union Camp Corporation, Savannah, Georgia

Boiler Rating: 800,000 lbs/hr.

Fuel: Wood waste, coal, oil

Mechanical Collector: No

Precipitator Design Conditions:	Volume - 338-441,000 acfm Loading - 4.69 gr/acf Outlet - 0.019 Efficiency - 99.59%	
Precipitator Data:	2 chambers, 5 fields, 10 power supplies, pyramidal hoppers, pneumatic dust removal.	

Figure 2 shows the general arrangement of a typical power boiler installation.

The experience derived from the operating installations described leads to a few conclusions, observations and recommendations as follows:

Design vs. Actual Variations

A substantial degree of conservatism is indicated in the actual operating conditions as compared to design conditions, i.e.

	Design Avg.	Actual Avg.
Inlet Loading, gr/acf	0.788	0.197
Outlet Loading, gr/acf	0.0115	0.0036
Volume, acfm	346,000	311,000

It can be seen that the inlet dust burden is actually about 25% of design and emissions about 30# of that required. Coupled with a design gas volume 10% in excess of actual, it is obvious that the equipment is oversized. As an example, using the actual inlet loading measured and the required (design) outlet, the efficiency level is 94.16% rather than 98.54% (avg. required by spec). Translated into cost, this can represent about 25% differential in capital expenditures. We are not suggesting that conservatism in design or a cushion against deterioration or operational changes is undesirab.e.

Problem Areas

The difficulties experienced to date have been primarily in two areas, fire damage and dust removal. Of the various units in service, one experienced serious fire damage during a severe boiler upset, one experienced hopper fires due to a malfunctioning dust removal system and one had apparent minor fire lamage due to an unknown cause. The problems associated with dust removal seem to be restricted to those units equipped with pyramidal hoppers (as opposed to trough type) and pneumatic removal systems (as opposed to mechanical). As a result of experience to date, the following recommendations are offered:

1. Use of trough hoppers and continuous dust removal by means of conveyors (chain or screw) is advisable.
2. There is no viable fire prevention or extinguishing means. Once those conditions exist which foster combustion, it is almost spontaneous. Temperature and oxygen monitors are certainly a benefit, but not a cure. Good, efficient boiler operation, close control of fuel feed and oxygen are the preventatives. Those plants with efficient boiler operation (oxygen levels as low as 5.5%) and proper dust removal have not experienced fires. More detail on this topic may be found in the paper listed in the Appendix.

In conclusion, we submit that experience derived during the past several years has established that electrostatic precipitators are an efficient, and dependable means of treating effluent gases from multiple fuel fired boilers.

Appendix: "The Control of Fires in Electrostatic Precipitators on Power Boilers"
Dr. Brian W. Doyle
KVB, Inc., Elmsford, New York

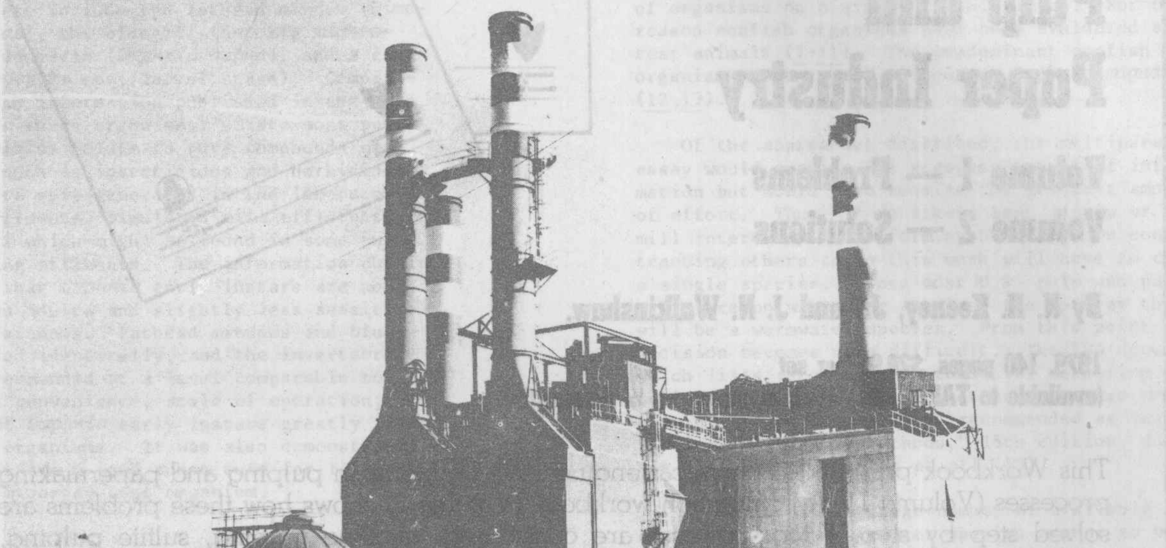

Figure 2. Typical Multiple Fuel Power Boiler Precipitator