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ENVIRONMENTAL MONITORING FOR THE DOE COOLSIDE AND LIMB DEMONSTRATION EXTENSION PROJECTS

DE-FC22-87PC 79798

FINAL REPORT FOR THE PERIOD OF
NOVEMBER AND DECEMBER 1990, AND JANUARY 1991

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1.0 INTRODUCTION

The purpose of this document is to present environmental monitoring data collected during the U.S. Department of Energy Limestone Injection Multistage Burner (DOE LIMB) Demonstration Project Extension at the Ohio Edison Edgewater Generating Station in Lorain, Ohio. These data were collected by implementing the Environmental Monitoring Plan (EMP) for the DOE LIMB Demonstration Project Extension, dated August 1988. This document is the fifth EMP status report to be published and presents the data generated during November and December 1990, and January 1991. These reports review a three to four month period and have been published since the project's start in October 1989.

The DOE project is an extension of the U. S. Environmental Protection Agency's (EPA) original LIMB Demonstration. The program is operated under DOE's Clean Coal Technology Program of "emerging clean coal technologies" under the categories of "in boiler control of oxides of sulfur and nitrogen" as well as "post-combustion clean-up." The objective of the LIMB program is to demonstrate the sulfur dioxide (SO_2) and nitrogen oxide (NO_x) emission reduction capabilities of the LIMB system. The LIMB system is a retrofit technology to be used for existing coal-fired boilers equipped with electrostatic precipitators (ESPs).

As required in the Cooperative Agreement between DOE and Babcock and Wilcox (B&W), an Environmental Information Volume (EIV), an Environmental Monitoring Plan Outline (EMPO), and an Environmental Monitoring Plan (EMP) were prepared prior to the onset of the DOE project. The EIV was dated May 20, 1987, the EMPO was dated December 23, 1987, and the final EMP was dated August 11, 1988.

This report is organized as follows: Section 1.0 is the Introduction; Section 2.0 presents a Summary of the project for the stated reporting period; Section 3.0 discusses the LIMB Process and the Project Status; Section 4.0 presents Source Monitoring

Information; Section 5.0 presents Ambient Monitoring Information; Section 6.0 presents the Health and Safety related information; Section 7.0 discusses the Compliance Monitoring Status; Section 8.0 discusses Quality Assurance/Quality Control Results; and Section 9.0 presents Monitoring Problems and Recommendations for Change. Support material related to air emissions and water discharges is presented in the appendices.

2.0 SUMMARY

This section presents a summary of EMP related items which occurred during the November and December 1990, and January 1991 reporting period.

The LIMB system was operated this reporting period to evaluate the flue gas desulfurization efficiency of two calcium-based sorbents (dolomitic lime and limestone) during the combustion of three different sulfur content coals (nominal 1.6, nominal 3.0, and nominal 3.8 percent sulfur by weight). Four sorbent/coal combinations were evaluated during the following six injection periods:

- dolomitic lime/nominal 1.6 percent sulfur coal, 11/01 - 11/12/90;
- dolomitic lime/nominal 3.0 percent sulfur coal, 11/13 - 11/16/90;
- dolomitic lime/nominal 1.6 percent sulfur coal, 11/17 - 11/27/90;
- dolomitic lime/nominal 3.8 percent sulfur coal, 11/28 - 12/04/90;
- dolomitic lime/nominal 1.6 percent sulfur coal, 12/5 - 12/21/90; and
- limestone/nominal 1.6 percent sulfur coal, 01/01 - 02/01/91.

The monitoring data and air quality modeling data presented in this report are based on emission data that are specific to the coal/sorbent combination utilized during a specific injection period and the combination of combustion and air pollution control equipment used at the Lorain facility. To determine LIMB operating efficiencies and environmental impacts, monitoring data collected during the sorbent/coal injection periods were compared to Baseline data. Baseline was the period from February 17 to April 22, 1990, where nominal 1.6 percent sulfur coal or "compliance coal" was fired and no LIMB Extension equipment was in operation.

Since the goal of the LIMB Demonstration Program is to test a wide range of operating conditions, the SO_2 and NO_x emissions averages should not be taken as representative of long-term optimized operations. For this reason, ranges of SO_2 and

NO_x data were compiled during periods of formal testing and may include both injection and non-injection periods within a given day.

During this reporting period the average SO_2 mass emission rate was highest during the dolomitic lime/nominal 3.8 percent sulfur coal injection period and was lowest during the dolomitic lime/nominal 1.6 percent sulfur coal injection period. The SO_2 mass emission rate during this reporting period varied from 520 to 5300 lb/hr. The average SO_2 mass emission rate for each injection period, which ranged from 1700 to 3700 lb/hr, was higher than average SO_2 mass emission rate during the Baseline period of 932 lb/hr. The median SO_2 removal efficiency was the highest during the dolomitic lime/nominal 3.0 percent sulfur coal injection period and the lowest during the limestone/nominal 1.6 percent sulfur coal injection period. SO_2 removal efficiencies for the reporting period varied widely, from 7.7 to 63 percent.

The average NO_x mass emission rate for the four sorbent/coal combinations ranged from 99 to 470 lb/hr this reporting period. The average NO_x mass emission rates for each injection period, which ranged from 290 to 370 lb/hr, were greater than the Baseline average NO_x emission rate of 181 lb/hr. However, with the installation of B&W XCL low-NO_x burners, NO_x emissions during this reporting period have decreased when compared with emissions which occurred prior to the EPA LIMB Demonstration. Modeled ambient air impacts from SO_2 and NO_x emissions during these six injection periods will be presented in the next report. Additional information on gaseous emission monitoring is presented in Section 4.1.

The wastewater discharge at Outfall 601 was monitored during this reporting period. All discharge parameters were within National Pollution Discharge Elimination System (NPDES) permit requirements. The change in concentration from the Baseline to each sorbent/coal combination for the NPDES discharge parameters is summarized in Table 2-1. No total phosphorus (P) analyses were performed during this reporting period. Additional information on wastewater monitoring is presented in Section 4.2.

TABLE 2-1. COMPARISON OF NPDES OUTFALL 601 MONITORING DATA DURING BASELINE AND EXTENSION PERIODS OF OPERATION

Parameter (Units)	SORBENT/COAL COMBINATION			
	Dolomitic Lime/Nominal 1.6 Percent Sulfur Coal	Dolomitic Lime/Nominal 3.0 Percent Sulfur Coal	Dolomitic Lime/Nominal 3.8 Percent Sulfur Coal	Limestone/Nominal 1.6 Percent Sulfur Coal
Average As (μg/L)	+	NA	NA	-
Average Ca (L)	NC	+	+	-
Average TSS (L)	-	-	-	-
Average O&G (L)	+	NA	NA	+
Max pH (s.u.)	+	+	+	+
Min pH (s.u.)	+	+	+	+

+ = increase from Baseline concentration.

- = decrease from Baseline concentration.

NC = no change from Baseline concentration.

NA = no analyses.

Fly ash samples were composited during the four sorbent/coal combinations. The resulting samples were submitted for corrosivity and permeability tests, and were leached using the Toxicity Characteristic Leaching Procedure (TCLP) and a deionized water (DI) leaching procedure--American Society for Testing and Materials (ASTM) D3987. These two leaching procedures will allow for the analyses of all targeted parameters listed in the EMP. The analytical results for October 1990 to January 1991 injection periods will be reported in the February, March, and April 1991 report.

Air quality modeling was performed in this reporting period for the dolomitic lime/nominal 1.6 percent sulfur coal and dolomitic lime/nominal 3.0 percent sulfur coal injection periods of the previous reporting period. The modeling demonstrated that SO_2 and NO_x concentrations increased over Baseline period concentrations, and that these increases exceeded the ambient air significance levels, as defined in the Prevention of Significant Deterioration (PSD) air regulations (40 CFR 51.166). The 3-hour (1.0 $\mu g/m^3$) and 24-hour (5 $\mu g/m^3$) significance levels for SO_2 were exceeded during both sorbent/coal injection periods (standards for 3-hour and 24-hour averages for NO_x do not exist). Of the NO_x and SO_2 annual ambient air significance levels, only the annual SO_2, significance level (25 $\mu g/m^3$) for the dolomitic lime/nominal 3.0 percent sulfur coal injection period was exceeded. Since SO_2 significance levels were exceeded, additional modeling, using the Industrial Source Complex Short Term (ISCST) dispersion model, was conducted to determine compliance with the National Ambient Air Quality Standard (NAAQS) for SO_2 during both injection periods. The modeling results demonstrate that the SO_2 NAAQS were not exceeded during any of the sorbent/coal injection periods. Additional information on dispersion modeling is presented in Section 5.1. Air dispersion modeling will be conducted in the next reporting period using emission data from the dolomitic lime and limestone sorbent injection periods within this reporting period.

Employee health and safety monitoring was conducted from October 31 to November 6, 1990 and is detailed in Section 6.0. Radian industrial hygiene personnel

conducted two sampling episodes (identified as episodes 1 and 3) to examine potential worker exposure hazards for Ca, As, lead (Pb) and respirable silica while the LIMB equipment was operating (October 31 - November 7, 1990). Noise exposures were also measured. All exposures for all chemical parameters were below the Occupational Health and Safety Administration (OSHA) Permissible Exposure Limits (PELs) and the American Congress of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs). Results were also below the mass detection limits. Noise exposures confirmed the need for hearing protection in the vicinity of LIMB equipment and for a hearing conservation program for certain operator positions (A hearing conservation program is already in place for these positions at the Ohio Edison facility). Additional information on health and safety is presented in Section 6.0.

The facility's compliance monitoring status was reviewed for this period. No air or NPDES permit values, as monitored by Ohio Edison and Radian, were exceeded during this reporting period. Additional information on compliance monitoring is presented in Sections 7.0 and 9.0.

3.0 PROJECT STATUS

The section presents information on the background of the LIMB project as well as the current project status.

3.1 Overview

The DOE LIMB Demonstration Project Extension is a continuation of a LIMB technology demonstration sponsored by the EPA. The purpose of the LIMB system is to reduce SO_2 and NO_x emissions from existing utility power generation plants using cost effective retrofit technologies. Specific goals of the EPA program were to demonstrate 50 to 60 percent reduction of SO_2 emissions based on incoming coals containing a nominal 3 percent sulfur. NO_x emissions were expected to be less than 0.5 lb/million Btu heat input. LIMB has the potential to reduce SO_2 emissions at a much lower cost than flue gas desulfurization (FGD) systems, or switching to low-sulfur coals imported from other regions.

3.2 Edgewater Facility Description

The LIMB Technology Demonstration is taking place at the Ohio Edison Edgewater Steam Electric Generating Plant located on Lake Erie in Lorain, Ohio. The Edgewater facility has a total net demonstrated power capability of 214 MW and consists of three pulverized coal-fired boilers serving two turbines and two oil-fired combustion turbine generators. The LIMB system was installed in 1986 on Edgewater Unit No. 4, which has a nameplate capacity of 105 MW. The boiler associated with Unit No. 4 turbine generator is Boiler No. 13. This unit is a B&W, front wall-fired boiler capable of burning 42.5 tons per hour (tph) of coal. Particulate emissions from Unit No. 4 are controlled with a Lodge-Cottrell ESP, which was retrofitted to the system in 1982.

Prior to the LIMB Demonstration, the Edgewater facility burned eastern bituminous coal (nominal 1.6 percent sulfur). Total station coal consumption is approximately 70 tph with all units in operation. The coal is delivered by truck. The facility utilizes 110 million gallons per day (MGD) of once-through cooling water taken from Lake Erie, and discharges 1.1 MGD of wastewater to the lake from the fly ash settling ponds. During LIMB Extension activities, fly ash from Unit No. 4 is trucked to a municipal landfill located in the Dover Township. Figure 3-1 presents a simplified schematic of the Edgewater facility layout.

Additional information on the Edgewater facility can be found in the EIV and previously prepared reports for this project.

3.3 The LIMB Process

The LIMB process utilizes low-NO_x burners to control the formation of NO_x emissions. To accomplish this reduction, Unit No. 4's original circular register burners were replaced with B&W XCL low-NO_x burners. The burner replacement was completed in 1986 during the EPA Demonstration, and these burners are still in use at this time.

Sorbent is injected into the combustion gas stream to provide sites for SO_2 sorption with downstream particulate collection by the ESP. Two injection systems are currently in place at the Edgewater facility. The first system injects sorbent directly into the boiler. All EPA LIMB Demonstration tests were completed using this configuration. However, as per EPA recommendations, a flue gas humidifying chamber was built in a bypass duct downstream of the boiler. The objective was to increase particulate removal efficiency of the ESP. By decreasing the flue gas temperature, the residence time of the flue gas in the ESP was increased, thereby allowing more time for particulate removal. Also, the resistivity of the fly ash was decreased, which allowed for greater particle-ESP plate attraction and hence, removal. The humidifying chamber was constructed in a

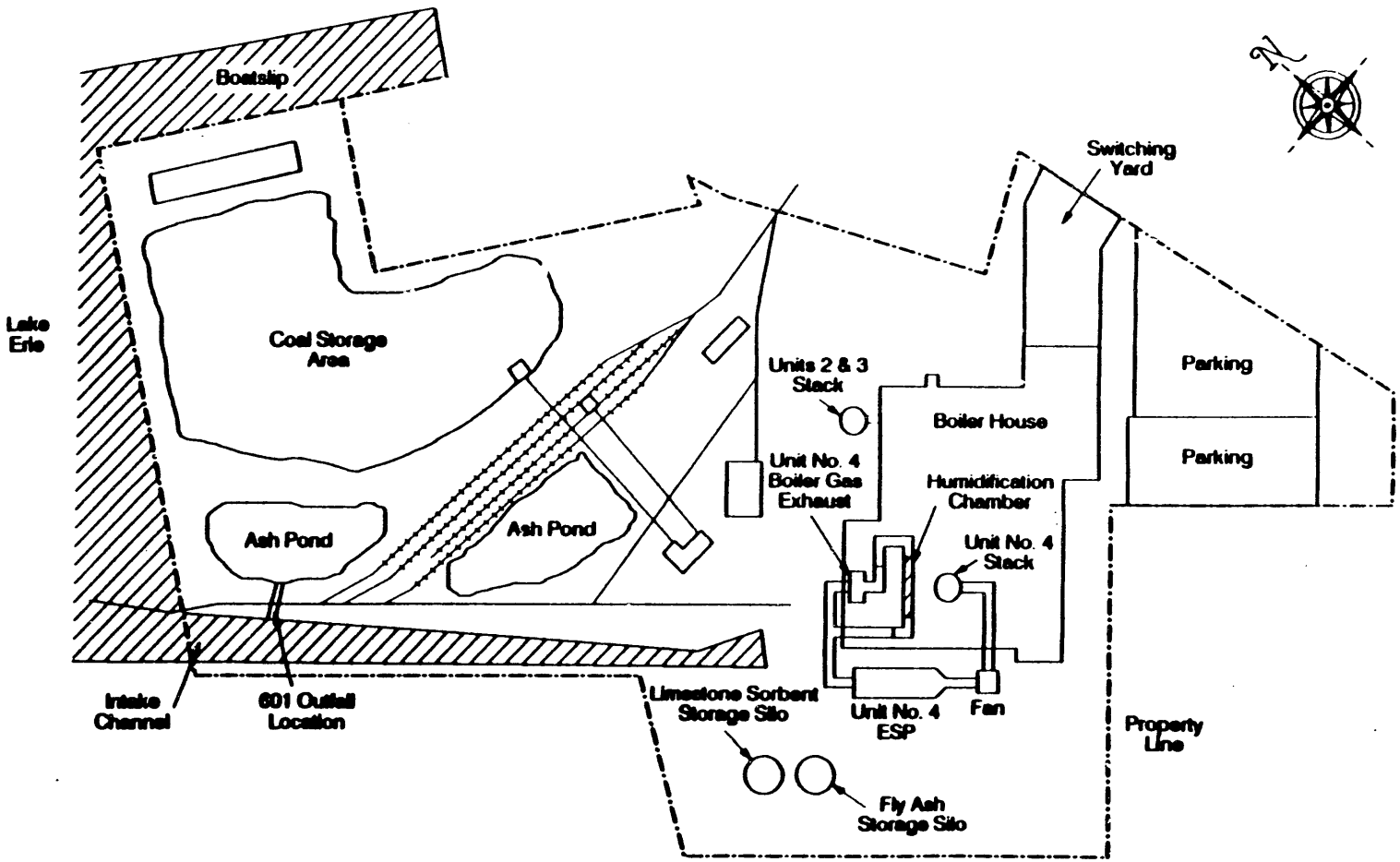

Figure 3-1. Edgewater Plant Site Layout

bypass duct so that it could be isolated during system upsets and not reduce the generation capability of the unit.

The DOE LIMB Demonstration Project Extension combines the original boiler sorbent injection with an additional sorbent injection point located upstream of the flue gas humidification. The additional Demonstration system, known as the "Coolside" process, involved sorbent injection upstream of the humidification chamber and was used in the initial stages of the LIMB Extension project. In addition to solid sorbent injection, a sodium hydroxide solution was added to the humidifying water to enhance SO_2 removal. Figure 3-2 presents a generalized schematic of the current sorbent injection configurations present at the Edgewater Facility.

In order to accurately document and analyze SO_2 and NO_x reduction efficiencies, as well as boiler operational efficiencies, a variety of parameters are monitored. Boiler operation measurements such as fluid temperatures, pressures, and flow rates are continuously monitored, as are stack gas concentrations of SO_2, NO_x, oxygen (O_2), carbon dioxide (CO_2), carbon monoxide (CO), and opacity. The boiler parameters are monitored by B&W using a computer-based data acquisition system (DAS) known as the Boiler Performance Diagnostic System 140. Up to 1000 data points are scanned and recorded on magnetic media every 60 seconds. System 140 also performs several hundred data calculations using the input measurements. All flue gas component concentrations -- SO_2, NO_x, CO, O_2, and CO_2 -- are monitored at the ESP outlet. Radian also monitors and records component concentrations with a separate personal computer (PC)-based DAS. Data from both DAS's are used in determining stack gas emission rates.

3.4 Project Design and Background

The EPA LIMB Demonstration was initiated in September 1984. B&W, as the prime contractor, has subcontracted with Radian Corporation to perform environmental

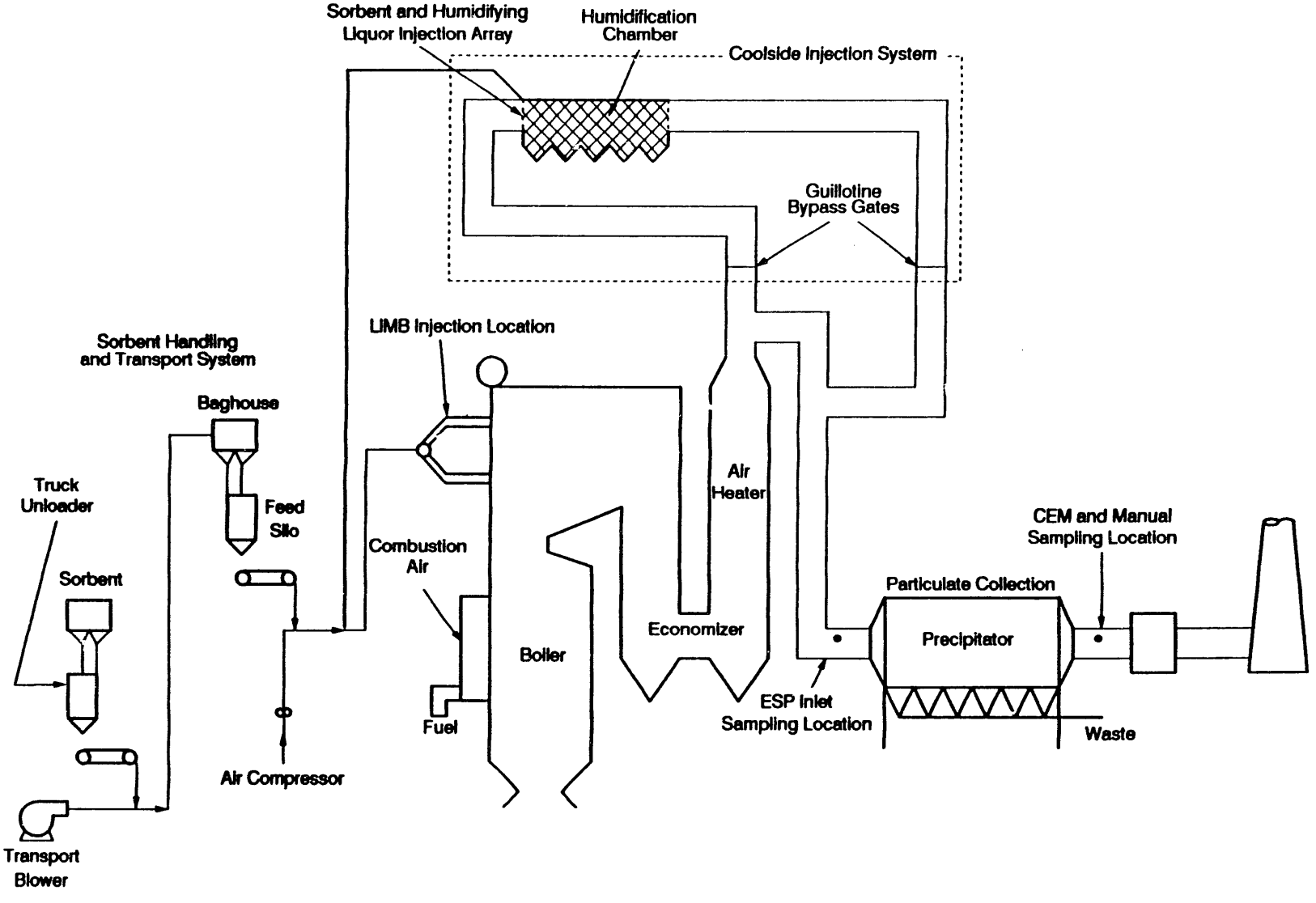

Figure 3-2. LIMB Injection and Coolside Injection Locations and Flue Gas Sampling Locations for the DOE LIMB Extension Project

monitoring throughout the Demonstration. The following testing phases were conducted during the EPA Demonstration:

Baseline Tests - Conducted prior to any modifications to Unit No. 4. The term "Baseline" in this report also refers to a period when sorbent was not injected into Boiler No. 13 or downstream ductwork.

Low NO_x Burner Tests - Conducted after installation of the low-NO_x burners.

LIMB Optimization and Demonstration - Conducted after installation of the boiler sorbent injection system. Final testing of this phase was completed with the bypass humidification chamber in place.

Preparation for the DOE sponsored LIMB Demonstration with the Coolside testing configuration started in July 1989. A shakedown period was conducted for several months to determine optimum operating conditions. The DOE Coolside tests started October 1989 and were completed on February 16, 1990. During the period from February 17 to April 22, 1990, a non-LIMB operation or Baseline period was in progress. Following the Baseline period, the DOE LIMB Demonstration Project Extension commenced. The Extension involves sorbent injection into the boiler in conjunction with the humidification chamber operation to maintain ESP performance. When load conditions permit, tests are run close to saturation conditions.

3.5 Project Status

Coolside process tests ended on February 16, 1990. During the weeks following, the system was reconfigured to accommodate boiler injection. The Baseline period occurred from February 17 to April 22, 1990. An equipment/operational shakedown period then followed, during which lignosulfonated lime was used while nominal 3.0 percent sulfur coal was burned. This condition was chosen in order to establish that the system would perform as it had prior to the Coolside test period.

The LIMB Extension system was started on April 23, 1990. System performance was monitored in the April to July 1990 reporting period for the following sorbent/coal combinations: 1) lignosulfonated lime/nominal 3.0 percent sulfur coal; 2) limestone/nominal 3.0 percent sulfur coal; and 3) limestone/nominal 1.6 percent sulfur coal. The system was then shut down on July 21, 1990 for a scheduled maintenance outage.

The LIMB Extension system was again started on August 14, 1990. When low sulfur coal was burned, a number of short sorbent/coal injection periods (each less than 8 hours per day) followed, a format which has continued to date. When high sulfur coal was burned, the injection system was run full-time and data collected continuously. The coal and sorbent combinations tested during the August to October, 1990 reporting period were: 1) dolomitic lime/nominal 1.6 percent sulfur coal; and 2) dolomitic lime/nominal 3.0 percent sulfur coal.

The LIMB system was operated this reporting period to evaluate the flue gas desulfurization efficiency of two calcium-based sorbents (dolomitic lime and limestone) during the combustion of three different sulfur content coals (nominal 1.6, nominal 3.0, and 3.8 percent sulfur by weight). The following four sorbent/coal combinations were evaluated during six injection periods this reporting period:

- dolomitic lime/nominal 1.6 percent sulfur coal, November 1 - 12, 1990, November 17 - 27, 1990, and December 5 - 21, 1990;
- dolomitic lime/nominal 3.0 percent sulfur coal, November 13 - 16, 1990;
- dolomitic lime/nominal 3.8 percent sulfur coal, November 28 - December 4, 1990;
- limestone/nominal 1.6 percent sulfur coal, January 1 - February 1, 1991.

4.0 SOURCE MONITORING

The Edgewater facility has several environmental discharge streams that are affected by the DOE LIMB program. This section divides the discharge source monitoring reporting into three areas. Unit No. 4 gaseous emissions are covered in Section 4.1, wastewater discharges are covered in Section 4.2, and solid waste discharges are covered in Section 4.3. Monitoring of pollution control limits and equipment is discussed in Section 4.4.

4.1 Gaseous Emissions Monitoring

There are two stacks at the Edgewater facility. Exhaust gases from Unit No. 4 are emitted through a stack located on the roof of the Unit No. 4 boiler house. Unit No. 3 flue gases are emitted through a stack located adjacent to the northern side of the boiler house. As a part of the DOE LIMB Extension test matrix, Unit No. 4 flue gas concentrations of NO_x, SO_2, CO, CO_2, and O_2 as well as opacity measurements are continuously monitored. Manual stack gas tests have been conducted for total particulate matter (PM), total particulate matter below 10 microns (PM_{10}) and particle size distribution tests.

A summary of average air emissions data is presented in Table 4-1, by test period. Average values in the table are arithmetic means of nonzero daily values recorded or calculated on days when Unit No. 4 and the sorbent injection equipment were operating at least some period of time. However, a detailed analysis that breaks down data into shorter averaging periods is outside the scope of the EMP reporting requirements. Air emissions data for O_2 and CO_2 are not included in the summary table since they are not considered to be pollutants. Data for CO is only used as a measurement of combustion efficiency and is therefore also not included in the summary tables. Monitoring data for O_2, CO_2 and CO are only reported and evaluated if the modeling results from SO_2 or NO_x are found to be questionable. In addition, the results from total hydrocarbon

TABLE 4-1. SUMMARY OF AIR EMISSIONS DATA[a]

Average Coal Firing Rate (klb/hr)	Average Higher Heating Value (Btu/lb)	Average Opacity (%)	Average, Maximum & Minimum SO_2 Emissions		Median, Maximum & Minimum SO_2 Removal Efficiency[c] (%)	Average, Maximum & Minimum NO_x Emissions	
			(lb/MMBtu)	(lb/hr[b])		(lb/MMBtu)	(lb/hr[b])
Dolomitic Lime/Nominal 1.6 Percent Sulfur Coal: 11/01 through 11/12/90, 11/17 through 11/27/90, and 12/05 through 12/21/90							
55	12,526	5.8	2.40	1,700	28	0.42	300
			3.7	2,400	59	0.48	470
			1.8	520	14	0.35	99
Dolomitic Lime/Nominal 3.0 Percent Sulfur Coal: 11/13 through 11/16/90							
65	12,596	3.7	3.7	3,000	29	0.45	370
			3.8	3,300	63	0.48	430
			3.5	2,700	12	0.41	300
Dolomitic Lime/Nominal 3.8 Percent Sulfur Coal: 11/28 through 12/04/90							
65	12,643	7.1	4.5	3,700	27	0.42	350
			6.0	5,300	51	0.48	400
			3.8	3,000	7.7	0.36	330
Limestone/Nominal 1.6 Percent Sulfur Coal: 01/01 through 01/21/91							
57	12,489	1.1	2.5	1,800	4	0.41	290
			2.8	2,300	36	0.44	400
			2.4	1,500	9.4	0.36	200
Overall Reporting Period Average: 11/01/90 through 02/01/91							
61	12,564	4.4	3.3	2,500	25	0.43	330
			6.0	5,300	63	0.48	470
			1.8	520	7.7	0.35	99
Baseline Period[e]: 02/17 through 04/22/90							
53	11,680	1.3	1.4	932	NA[f]	0.28	181

[a] All emissions are calculated for each day, as shown in Appendix A. The values represent the average of those daily calculated values. Average lb/hr values for each reporting period can be verified using the formula in footnote "b".

[b] Values calculated as lbs/hr = [(lbs/MMBtu)(klb/hr)(Btu/lb)(1000 lb/klb)/(10^6 Btu/MMBtu)].

[c] Values presented here are not a direct indication of system performance. Calculations incorporate recorded data taken only during days when there was at least some LIMB operation. Zero values for off-line days were not used in calculating averages.

[d] ND = not determined.

[e] The data for baseline period results are presented in the report for the period of February, March and April 1990.

[f] NA - not applicable.

(THC) testing, which were below 1 ppmv for the U.S. EPA portion of the Base LIMB testing project (Baseline Report, 1988) demonstrated that no further THC monitoring was required. Because the goal of the demonstration program is to test a wide range of operating conditions, these air emission averages should not be taken as representative of long-term, optimized operations. For this reason, ranges of SO_2 data have been shown and may include both injection and noninjection periods within a given day.

The testing which occurred during this reporting period was largely performed during short time periods (2 to 6 hours per day). This method of testing was employed throughout most of this reporting period. However, when high sulfur coal was burned, testing took place continuously.

The average SO_2 emission rate was highest during the dolomitic lime/nominal 3.8 percent sulfur coal injection period and was the lowest during the limestone/nominal 1.6 percent sulfur coal and dolomitic lime/nominal 1.6 percent sulfur coal injection periods. The SO_2 mass emission rate during this reporting period varied from 520 to 5,300 lb/hr. The average SO_2 mass emission rate for each injection period, which ranged from 1,700 to 3,700 lb/hr, was higher than average SO_2 emissions during the Baseline period of 932 lb/hr. The median SO_2 removal efficiency was highest during the dolomitic lime/nominal 3.0 percent sulfur coal injection period and lowest during the limestone/nominal 1.6 percent sulfur coal injection period. The range of SO_2 removal efficiencies for the reporting period was 7.7 to 63 percent.

Average NO_x mass emission rates for the four sorbent/coal combinations ranged from 99 to 470 lb/hr this reporting period. The average NO_x mass emission rates for each injection period, which ranged from 290 to 370 lb/hr, were greater than the Baseline average NO_x emissions of 181 lb/hr. With the installation of B&W XCL low-NO_x burners, NO_x emissions during this reporting period have decreased when compared with emissions which occurred prior to the EPA LIMB Demonstration.

Ambient air impacts from SO_2 and NO_x emissions during these four coal-sorbent combinations will be evaluated in the next report.

The average opacity during each dolomitic lime injection period ranged from 3.7 to 7.1 percent, as compared to average opacity during the Baseline period of 1.3 percent. However, the opacity remained well below the permit limit of 20 percent. The average opacity decreased during the limestone injection period as compared to average opacity during the Baseline period. The average higher heating value (HHV) of the coal increased this reporting period over the Baseline period.

Daily emission rate data are presented in Appendix A. No manual flue gas testing was conducted for PM and particle size distribution during this reporting period. This type of testing requires that the boiler and air pollution control equipment be operating at steady conditions for a minimum of 4 and 24 hours respectively. The injection of sorbent in 2-6 hour periods precluded PM or PM_{10} tests from being performed.

Calculations for determining flow rates, moisture contents, isokinetics, and particulate emissions were made during these tests using a computer software program developed by Radian. This program uses the calculation procedures and equations specified in EPA Methods 2, 4, and 5. The program has been successfully used for numerous test efforts and has been validated by independent performance audits.

4.2 Wastewater Monitoring

The wastewater discharge points at the Edgewater facility are shown in Figure 4-1. The wastewater Outfalls are listed below:

1. **Outfall 001** - consists of condenser cooling water and discharges to Lake Erie.
2. **Outfall 002** - consists of intermittent storm water runoff from the fuel tank spill containment basin area, and also discharges to Lake Erie.

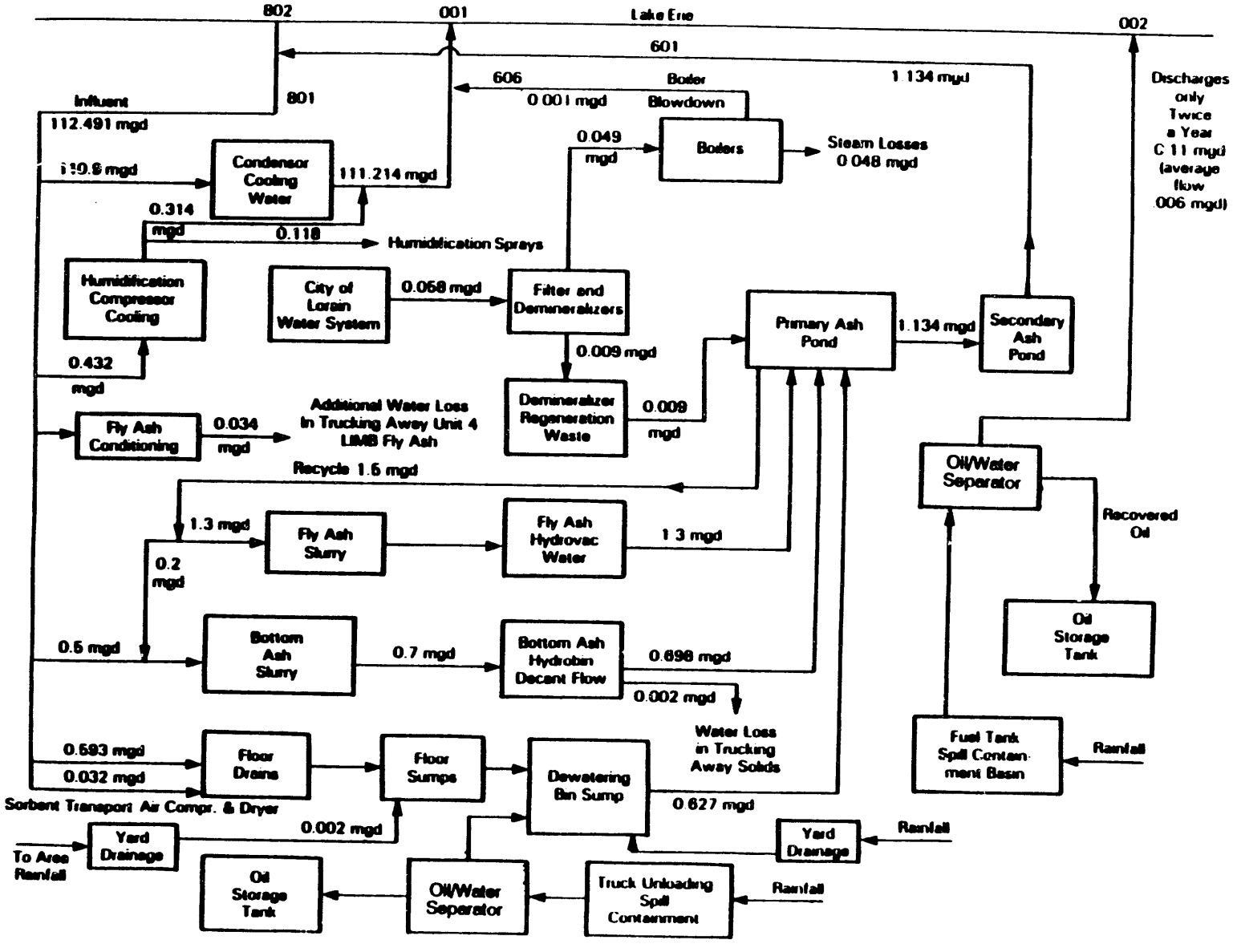

Figure 4-1. Flow Diagram of Edgewater Plant Water Flows and Outfalls

3. **Outfall 601** - discharges secondary ash pond effluent. Outfall 601 consists of all major plant wastewater streams and storm water runoff, including runoff from the truck loading area.

4. **Outfall 606** - consists of intermittent boiler blowdown discharge and drains to the Outfall 001 tunnel.

Only Outfall 601 contains any additional effluent or pollutant loadings as a result of the Coolside or LIMB Demonstration Project Extension testing. Compliance monitoring as required by the NPDES permit was conducted. Monthly discharge reports are submitted by Ohio Edison to the Ohio EPA for Outfalls 601, 606, 001, and 002 for the following parameters: pH, total suspended solids (TSS) (referred to in the permit as nonfilterable residue), flow, oil and grease (O&G), P, and arsenic (As). TSS, pH, and flow were measured twice a week; O&G, P, and As were measured once a month. Outfall 601 was monitored daily for pH and temperature. Daily wastewater samples were also composited during the four sorbent/coal combinations for Ca analyses. Appendix B provides NPDES analytical data for the months of November and December 1990, and January 1991. Temperature and pH data are shown in Appendix C for the period of November and December 1990, and January 1991. The Outfall 601 Ca analyses are shown in Appendix D.

Wastewater discharges at Outfall 601 were monitored during this reporting period. All discharge parameters were within National Pollution Discharge Elimination System (NPDES) permit requirements. Table 4-2 shows a comparison of the Baseline values versus the average, maximum, and minimum values for each parameter during the month indicated. Table 4-3 provides Outfall 601 wastewater quality data categorized by sorbent/coal combination. Table 4-4 presents the supplemental pH and Ca concentration data for Outfall 601 with the data categorized by sorbent/coal combination. It is important to note that Radian and Ohio Edison perform wastewater pH monitoring at different locations and times. As specified in the EMP, Radian takes daily pH measurements at the 601 outfall into Lake Erie. Ohio Edison monitors the pH as the wastewater flows from the primary settling pond to the secondary settling pond.

TABLE 4-2. NPDES OUTFALL 601 MONITORING DATA - NOVEMBER AND DECEMBER 1990, AND JANUARY 1991

Reporting Period	Parameters					
	pH (s.u.)	TSS (mg/L)	Flow (mgd)	O&G (mg/L)	P (mg/L)	As (μg/L)
Sampling Frequencies	2/week	2/week	2/week	1/month	1/month	1/month
Permit Requirements						
Daily Limit	6-9	100	--	20	--	--
Monthly Limit	6-9	30	--	15	--	--
November 1990						
Average	---	8	1.5	3[a]	NA[c]	162[a]
Maximum	8.3	15	1.6	3[a]	NA[c]	162[a]
Minimum	7.1	2	1.2	3[a]	NA[c]	162[a]
December 1990						
Average	---	9	1.4	b	NA[c]	58[a]
Maximum	8.3	22	1.7	b	NA[c]	58[a]
Minimum	7.2	2	0.9	b	NA[c]	58[a]
January 1991						
Average	---	12	1.1	2[a]	NA[c]	53[a]
Maximum	7.6	24	1.5	2[a]	NA[c]	53[a]
Minimum	7.0	4	0.7	2[a]	NA[c]	53[a]
Baseline[d] (2/17-4/22/90)						
Average	---	14	1.9	1	0.15	70
Maximum	7.70	26	2.1	1	0.25	90
Minimum	7.40	7	0.2	b	0.05	48

[a] Single data point for the month.

[b] Below detection limits.

[c] Not Analyzed during test period.

[d] Analytical data from February, March, and April 1990 Reporting Period

TABLE 4-3. SUMMARY OF NPDES OUTFALL 601 MONITORING DATA DURING BASELINE AND EXTENSION PERIODS OF OPERATIONS

Reporting Period	Parameters					
Average, Maximum, and Minimum	pH (s.u.)	TSS (mg/L)	Flow (MGD)	O&G (mg/L)	P (mg/L)	As (μg/L)
Sampling Frequencies	2/week	2/week	2/week	1/month	1/month	1/month
Permit Requirements						
Daily Limit	6-9	100	--	20	--	--
Monthly Limit	6-9	30	--	15	--	--
Dolomitic Lime/Nominal 1.6 Percent Sulfur Coal: 11/1 through 11/12/90, 11/17 through 11/27/90, and 12/05 through 12/21/90						
Average	--	8.4	1.5	2.5	NA[c]	110
Maximum	8.3	22	1.9	3	NA[c]	162
Minimum	7.1	2	1.1	b	NA[c]	58
Dolomitic Lime/Nominal 3.0 Percent Sulfur Coal: 11/13 through 11/16/90						
Average	---	10	1.6	NA[c]	NA[c]	NA[c]
Maximum	7.8	12	1.6	NA[c]	NA[c]	NA[c]
Minimum	7.4	8	1.5	NA[c]	NA[c]	NA[c]
Dolomitic Lime/Nominal 3.8 Percent Sulfur Coal: 11/28 through 12/04/90						
Average	--	7.5	1.6	NA[c]	NA[c]	NA[c]
Maximum	8.3	8	1.7	NA[c]	NA[c]	NA[c]
Minimum	7.6	7	1.6	NA[c]	NA[c]	NA[c]
Limestone/Nominal 1.6 Percent Sulfur Coal: 01/07 through 01/23/91						
Average	--	13	1.1	2[a]	NA[c]	53[a]
Maximum	7.6	29	1.5	2[a]	NA[c]	53[a]
Minimum	7.0	4	0.7	2[a]	NA[c]	53[a]
Overall Reporting Period Average: 11/01/90 through 01/31/91						
Average	--	10	1.3	2.5	NA[c]	91
Maximum	8.3	29	1.9	3	NA[c]	162
Minimum	7.0	2	0.7	2	NA[c]	53
Baseline Period: 02/17 through 04/22/90						
Average	--	14	1.9	0.5	0.15	70
Maximum	6.85	26	2.1	1	0.25	90
Minimum	6.52	7	0.2	b	0.05	48

[a] Single data point for the period.
[b] Below detection limits.
[c] Not Analyzed during test period.

TABLE 4-4. OUTFALL 601 pH[a] AND Ca[b] CONTENT

Sorbent/Coal Combination	Date of Sampling	Maximum pH (s.u.)	Minimum pH (s.u.)	Average Ca (mg/L)
Dolomitic Lime/Nominal 1.6 Percent Sulfur Coal	11/01 - 11/12/90 12/10 - 12/14/90 12/17 - 12/21/90	7.78	7.21	45
Dolomitic Lime/Nominal 3.0 Percent Sulfur Coal	10/29 - 10/31/90[c] 11/13 - 11/16/90 11/26 - 11/30/90	8.38	6.66	61
Dolomitic Lime/Nominal 3.8 Percent Sulfur Coal	11/28 - 12/04/90	8.38	7.21	59
Limestone/Nominal 1.6 Percent Sulfur Coal	01/07 - 01/18/91	7.78	6.97	43
Baseline:	02/17 - 04/22/90	6.85	6.32	45

[a]Daily pH data shown in Appendix B.
[b]Calcium analysis shown in Appendix D.
[c]pH data from August, September and October 1990 Reporting Period.

Because of the differences in time and location of data collection, pH measurements are likely to differ. The pH may change as operations change at the facility. For example, the pH may fluctuate in the settling ponds when ash trucks are loaded or sorbent is unloaded. Therefore, the values in Tables 4-3 and 4-4, hence Appendix B and C, are not neccessarily the same. Generally, the pH data in the two tables are within +/-0.5 pH units, a variation that is expected in neutral wastewater.

In addition, the monitoring data summarized in each report is from a variety of sources. Depending on the medium being sampled and the type of monitoring being performed, the dates of sampling may not match the sorbent/coal injection period. The dates of air emission and wastewater sampling recorded in Tables 4-1 and 4-3 do match the injection period. The sampling dates recorded in Table 4-4, however, differ from other sampling episodes, in that wastewater samples are being composited for calcium analyses on a weekly basis (as per the EMP). Therefore, if a sorbent/coal injection period does not start on a Monday, then the injection period will not match the sampling period.

The maximum and minimum pH measurements recorded during the four sorbent/coal combinations were greater than the maximum and minimum pH measurements recorded during the Baseline period. The wastewater Ca concentration values varied over a range of 43 to 61 mg/L during the reporting period. Only the wastewater Ca values during the limestone injection period were below the Baseline value. The average, maximum, and minimum concentration of As during the dolomitic lime/nominal 1.6 percent sulfur coal injection period increased from the Baseline; whereas, the average As concentration during the limestone/nominal 1.6 percent sulfur coal injection period was below the average Baseline concentration. No project specific reasons could be found to explain the increase in As concentrations during the dolomitic lime/1.6 percent sulfur coal injection period. The TSS concentrations during this reporting period increased from the previous reporting period; however, the TSS values decreased from the Baseline. The average, maximum, and minimum O&G concentrations reported this

period increased when compared to the Baseline. Again, there was no project specific reason found for the increase in O&G. These O&G values were measured very near the stated detection limit of 1 mg/l. No P analyses were performed during this reporting period.

4.3 Solid Waste Discharges

The two main solid waste streams generated from the Edgewater facility are boiler bottom ash and fly ash. A generalized schematic of the system is presented in Figure 4-2. Bottom ash generated during the project is not expected to present a major environmental impact due to the small quantity typically generated.

Utility waste such as fly ash is in an exempt category under the Resource Conservation and Recovery Act (RCRA). However, as a part of the EMP, the fly ash generated during Coolside and LIMB Extension activities will continue to be submitted for the TCLP and DI leaching procedure (ASTM D3987), with analysis of these leachates for selected parameters.

The EMP specifies ash testing for each sorbent/coal combination, with a sampling frequency of once per day during sorbent injection. Fly ash was sampled once a day in this reporting period; however, these analyses are not available for inclusion into this report. Fly ash was sampled only in October 1990 of the previous reporting period. During August and September 1990, lime injection was limited to daily test periods. Because these injection periods were so short, it was not possible to collect representative ash samples from the electrostatic precipitator (ESP) during these injection and non-injection periods. In October 1990, the testing program continued with short duration injection periods. At that time, Radian decided to attempt collection of representative ash samples from the ESP and from the ash truck loading chute. The fly ash analyses from sorbent/coal combinations collected from October 1990 to January

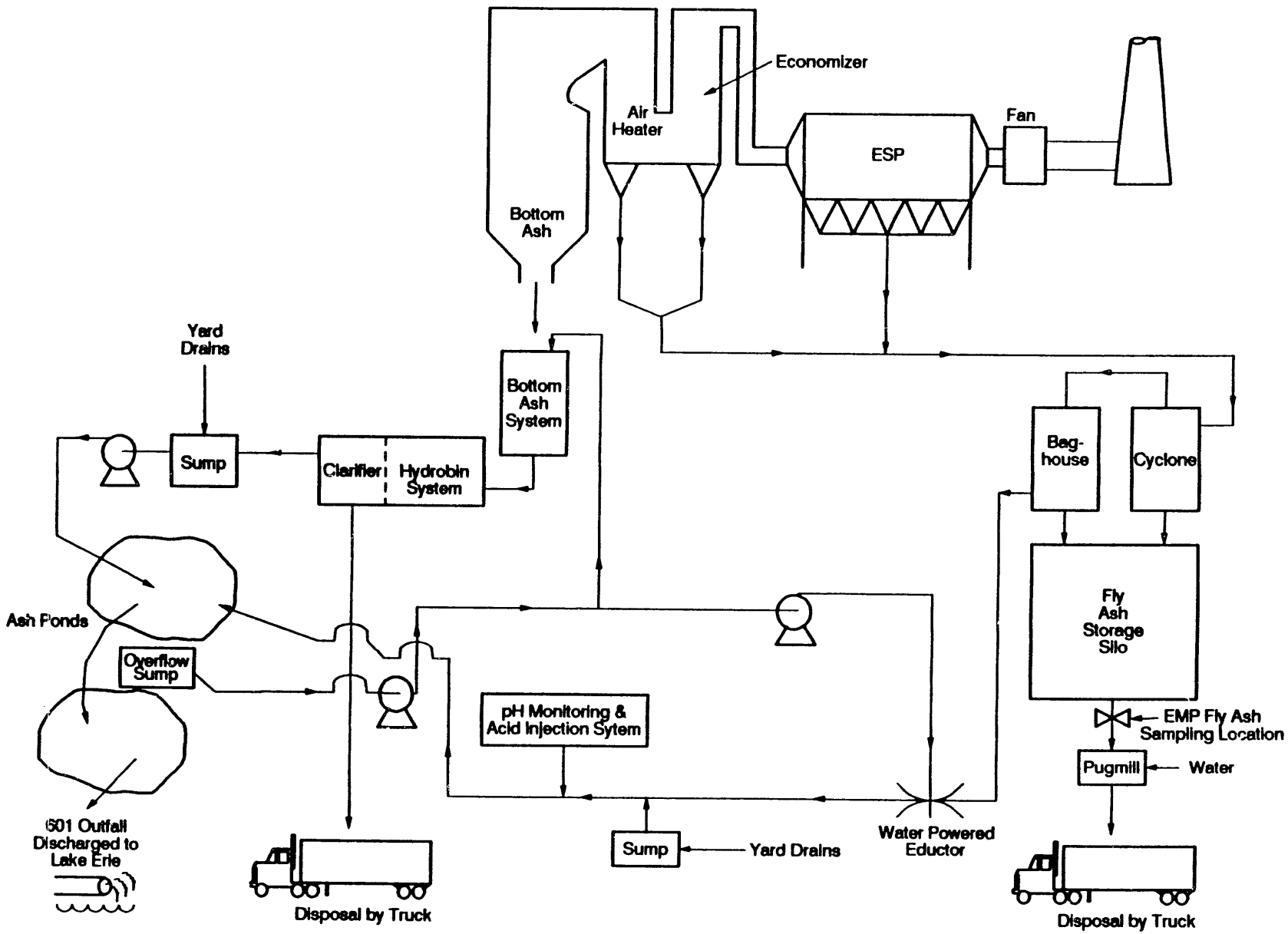

Figure 4-2. Edgewater Ash Handling System

1991 will be compared to those from the Baseline period in the February, March, and April 1990 Report.

4.4 Pollution Control Limit Monitoring

The pollution control systems for gaseous and aqueous discharges from Unit No. 4 were continuously monitored throughout the months of November and December 1990, and January 1991. Stack gas emissions from Unit No. 4 were controlled with the LIMB system and the existing ESP.

The LIMB operating log for the months indicated is presented in Table 4-5. Some of the reasons for various outages and system upsets are included in the table. In November 1990, the system operated for a total of 352.5 hours of formal testing. During December 1990, no formal testing was conducted for 13 days. The system operated for 331.5 hours of formal testing during the month, with the system off-line over the holidays. In January 1991, the system operated for a total of 130.5 hours of formal testing. Occasional shutdowns were reported for sorbent injection line repairs, plugged sorbent injection hoses, and to calibrate or "zero" monitoring equipment.

TABLE 4-5. LIMB OPERATION LOG FOR NOVEMBER AND DECEMBER 1990, AND JANUARY 1991

Date	Hours of Lime Injection		Hours of Humidification		Daily Hours of Formal Testing	Stoichiometry (average)	Humidifier Outlet Temp (F)	Daily Hours out of service
	From	To	From	To				
901101	0000	0330	0000	0400	3.5	1	260	20
901102	LIMB unit off-line.							
901103	LIMB unit off-line.							
901104	LIMB unit off-line.							
901105	1630	2400	1630	2400	7.5	1	260	16.5
901106	0000	2400	0000	2400	24	1	260	0
901107	0000	2400	0000	2400	24	1.5	260	0
901108	0000	1600	0000	2400	24	2	260	0
901109	LIMB unit off-line.							
901110	LIMB unit off-line.							
901111	LIMB unit off-line.							
901112	1000	2400	1000	2400	10	1.8	260	10
901113	0000	2400	0000	2400	24	2	260	0
901114	0000	2400	0000	2400	24	2	260	0
901115	0000	1300	0000	1300	22	1.5	260	2
	1500	2400	1400	2400				
901116	0000	2400	0000	2400	24	2	145/260	0
901117	0000	1600	0000	2000	16	1.3	260	4
901118	LIMB unit off-line.							
901119	1200	2400	1200	2400	0	1.4	260	12
901120	0000	2400	0000	2400	24	1.8	260	0
901121	0000	1500	0000	2100	21	1.8	260	3
901122	LIMB unit off-line.							
901123	LIMB unit off-line.							
901124	LIMB unit off-line.							
901125	LIMB unit off-line.							
901126	1100	1200	1100	1200	10.5	0.8	260	13.5
	1430	2400	1430	2400				
901127	0000	2400	0000	2400	24	2	260	0
901128	0000	2400	0000	2400	24	1.8	260	0
901129	0000	2400	0000	2400	24	1.8	260	0
901130	0000	2200	0000	2200	22	1.4/2.0	250/260	2
901201	LIMB unit off-line.							
901202	2300	2400	---	---	0	1	---	23
901203	0000	2400	0000	2400	24	1.6	260	0
901204	0000	2400	0000	2400	24	0.9	260	0
901205	0000	2300	0000	2300	23	2.3	260	1
901206	1300	2400	1300	2400	11	1.2	260	11
901207	0000	2200	0000	2200	22	1.3	250/260	2
901208	0800	2000	0800	2000	12	1.3	250	12
901209	LIMB unit off-line.							
901210	1430	2400	1430	2400	9.5	1.5	260	14.5
901211	0000	2400	0000	2400	24	1.7	260	0
901212	0000	2400	0000	2400	24	1.8	145/260	0
901213	0000	2400	0000	2400	24	1.8	250/260	0
901214	0000	2400	0000	2400	24	1	260	0
901215	0000	2100	0000	2100	21	1	260	3
901216	LIMB unit off-line.							
901217	0800	2400	0800	2400	16	1.2	145/260	8
901218	0000	0100	0000	0100	15	1	145/250	9
	1000	2400	1000	2400				
901219	0000	0700	0000	0700	21	2	194	3
	1000	2400	1000	2400				

TABLE 4-5. LIMB OPERATION LOG FOR NOVEMBER AND DECEMBER 1990, AND JANUARY 1991
(continued)

Date	Hours of Lime Injection		Hours of Humidification		Daily Hours of Formal Testing	Stoichiometry (average)	Humidifier Outlet Temp (F)	Daily Hours out of service
	From	To	From	To				
901220	0000	0700	0000	0700	21	1.5	250	3
	1000	2400	1000	2400				
901221	0000	2200	0000	2200	16	2	250	2
901222	LIMB unit off-line.							
901223	LIMB unit off-line.							
901224	LIMB unit off-line.							
901225	LIMB unit off-line.							
901226	LIMB unit off-line.							
901227	LIMB unit off-line.							
901228	LIMB unit off-line.							
901229	LIMB unit off-line.							
901230	LIMB unit off-line.							
901231	LIMB unit off-line.							
910101	1200	2400	---	---	12	1.2	---	12
910102	0000	0200	---	---	2	1.2	---	22
910103	1700	2400	1700	2400	7	1.5	260	17
910104	0000	0200	0000	0200	6	1.5	260	18
	1500	1900	1500	1900				
910105	LIMB unit off-line.							
910106	LIMB unit off-line.							
910107	1100	1600	1100	1600	5	2	260	19
910108	1300	1600	1300	1600	3	2	260/275	21
910109	1400	1800	1400	1800	4	1.6	145	20
910110	1100	1600	---	---	5	1.2	---	19
910111	1030	1630	1030	1630	6	1.8	145	18
910112	LIMB unit off-line.							
910113	LIMB unit off-line.							
910114	1430	1600	1430	1600	1.5	1.4	260	22.5
910115	1030	1800	1030	1800	7.5	1.4	145	16.5
910116	LIMB unit off-line.							
910117	1300	1630	---	---	3.5	1	---	20.5
910118	1000	1230	1000	1230	2.5	2.2	275	21.5
910119	LIMB unit off-line.							
910120	LIMB unit off-line.							
910121	1000	1300	---	---	3	2	---	21
910122	1200	1400	---	---	2	1	---	22
910123	LIMB unit off-line.							
910124	1000	1300	---	---	3	2	---	21
910125	1100	1330	---	---	2.5	1.6	---	21.5
910126	LIMB unit off-line.							
910127	LIMB unit off-line.							
910128	1000	1300	---	---	3	2	---	21
910129	1030	1500	1030	1500	4.5	1.6	---	19.5
910130	1030	1530	1030	1530	5	1.6	260	19
910131	1200	1730	---	---	5.5	1.2/2.2	---	18.5

5.0 AMBIENT MONITORING

This section presents the results of ambient air dispersion modeling and ground-water monitoring. Section 5.1 discusses ambient air impacts predicted by using dispersion models with data from the August, September, and October 1990 reporting period. Section 5.2 discusses ground-water monitoring.

5.1 Ambient Air Dispersion Modeling

Air dispersion modeling was conducted using the EPA SCREEN model to assess ground level pollutant concentrations during sorbent injection periods. The air quality results presented in this section are based on emission and stack parameter data that are specific to the coal/sorbent combination utilized during a specific test period and the combination of combustion/control equipment used at this facility. Ambient air dispersion modeling was performed to determine only site-specific air quality impacts. Since the predicted impacts are dependent on site-specific factors such as meteorological data, size of property (distance to nearest ambient air impact), type of combustion and air pollution control equipment employed, operating conditions (including percent sulfur of coal and degree of pulverization), and stack parameter data, the results of air quality modeling conducted using this combustion and control technology at another facility would be expected to vary on a case-by-case basis.

Air dispersion modeling was conducted to assess ground level pollutant concentrations during two injection periods. The first injection period, dolomitic lime/nominal 1.6 percent sulfur coal firing, occurred August 24 through October 5, 1990. The second injection period, dolomitic lime/nominal 3.0 percent sulfur coal firing, occurred from October 8 through October 30, 1990.

Modeling results show that the change in concentration (i.e., injection period maximum impacts minus baseline maximum impacts) is less than 1.0 $\mu g/m^3$ for NO_x for both sorbent/coal injection periods modeled. Results for SO_2 indicate an increase in impacts that is greater than the PSD significance criteria, over the baseline for the 3-hour, 24-hour and annual averaging periods. Additional modeling, using the ISCST model, demonstrates that the SO_2 NAAQS were not exceeded during any of the sorbent/coal injection periods.

The modeling methodology followed for this analysis and all other analyses was outlined in the report covering the period of October 1989 to January 1990. The five-part methodology compares modeled ground level concentrations for the no sorbent injection (Baseline) case and modeled ground level concentrations during each of the coal/sorbent combinations to be evaluated.

5.1.1 Air Quality Source Parameters

To determine the combination of stack parameter and emission rate data that will predict the maximum air quality impacts, two data sets of representative stack parameters and emission rates were evaluated for each sorbent/coal injection period. In general, plume dispersion, and therefore, maximum predicted impacts are dependent on the stack parameters input to the model. For example, a lower stack exit velocity can cause higher ambient impacts due to less plume dispersion. Therefore, the two sets of data considered for the analysis included the maximum SO_2 and NO_x emission rates and maximum stack exit velocity for each injection period, and the mean emission rates and stack exit velocity for each sorbent/coal injection period. These two data sets were input to the EPA SCREEN dispersion model to determine the most conservative set of operating conditions for each injection period. The SCREEN model results indicate that, for this location, the maximum impacts would occur when using the maximum emission rate and exit velocity rather than the average emission rate and exit velocity for both sorbent/coal injection periods.

The maximum emission rates and exit velocity, input to the more refined ISCST dispersion model, were based on daily emission rates reported during each injection period. A representative exit temperature of 350°K was obtained from B&W and input the ISCST model. The total suspended particulates (TSP) and CO emission rates are assumed not to change substantially during any portion of the LIMB Demonstration Project Extension. As a result, no comparison is made for these pollutants between the sorbent/coal injection periods and the Baseline period.

5.1.2 Air Quality Modeling Procedure

The modeling was performed as outlined in the protocol discussed in the report covering the November 1989 to January 1990 period. A five-year analysis (1981-1985) was performed for each scenario. The receptor grid used in the analysis, shown in Figure 5-1, is identical to the one described in previous reports.

5.1.3 Air Quality Modeling Results

The difference between the maximum baseline impacts and the maximum impacts for each sorbent/coal injection period are shown in Table 5-1. Positive values indicate an increase in modeled impacts over baseline impacts. The change in NO_x concentrations varies only slightly between injection periods, from 0.2 $\mu g/m^3$ during the dolomitic lime/nominal 1.6 percent sulfur coal to 0.3 $\mu g/m^3$ during the dolomitic lime/nominal 3 percent sulfur coal. The change in SO_2 concentrations is positive for all SO_2 averaging periods for each sorbent/coal injection period.

As outlined in the report covering the period of October 1989 to January 1990, increases in predicted air quality impacts over baseline conditions were compared to the ambient air significance levels as defined in the PSD air regulations [40 CFR 51.165(b)(2)]. For SO_2 and NO_x, these values are 1.0 $\mu g/m^3$ for the annual average, 5 $\mu g/m^3$ for the 24-hour average, and 25 $\mu g/m^3$ for the 3-hour average. For

TABLE 5-1. AIR QUALITY MODELING RESULTS[a]

Averaging Period	Location of the Impact X (m)	Location of the Impact Y (m)	Meteorological Data	PSD Ambient Air Significance Levels ($\mu g/m^3$)	Difference in Impacts: Dolomitic Lime/Nominal 1.6 percent sulfur Coal Combination minus Baseline SO_2 ($\mu g/m^3$)	Difference in Impacts: Dolomitic Lime/Nominal 1.6 percent sulfur Coal Combination minus Baseline NO_x ($\mu g/m^3$)	Difference in Impacts: Dolomitic Lime/Nominal 3.0 Percent Sulfur Coal Combination minus Baseline SO_2 ($\mu g/m^3$)	Difference in Impacts: Dolomitic Lime/Nominal 3.0 Percent Sulfur Coal Combination minus Baseline NO_x ($\mu g/m^3$)
Annual	0	500	1982	1.0	+0.6	+0.2	+3.3	+0.3
24-hour [b]	0	500	1984	5	+17.5	NA[b]	+46.3	NA[c]
3-hour [b]	0	500	1982	25	+45.3	NA[b]	+109.5	NA[c]

[a] No change in TSP or CO was assumed, therefore no delta analysis was performed.

[b] Highest second-highest impacts.

[c] Not applicable.

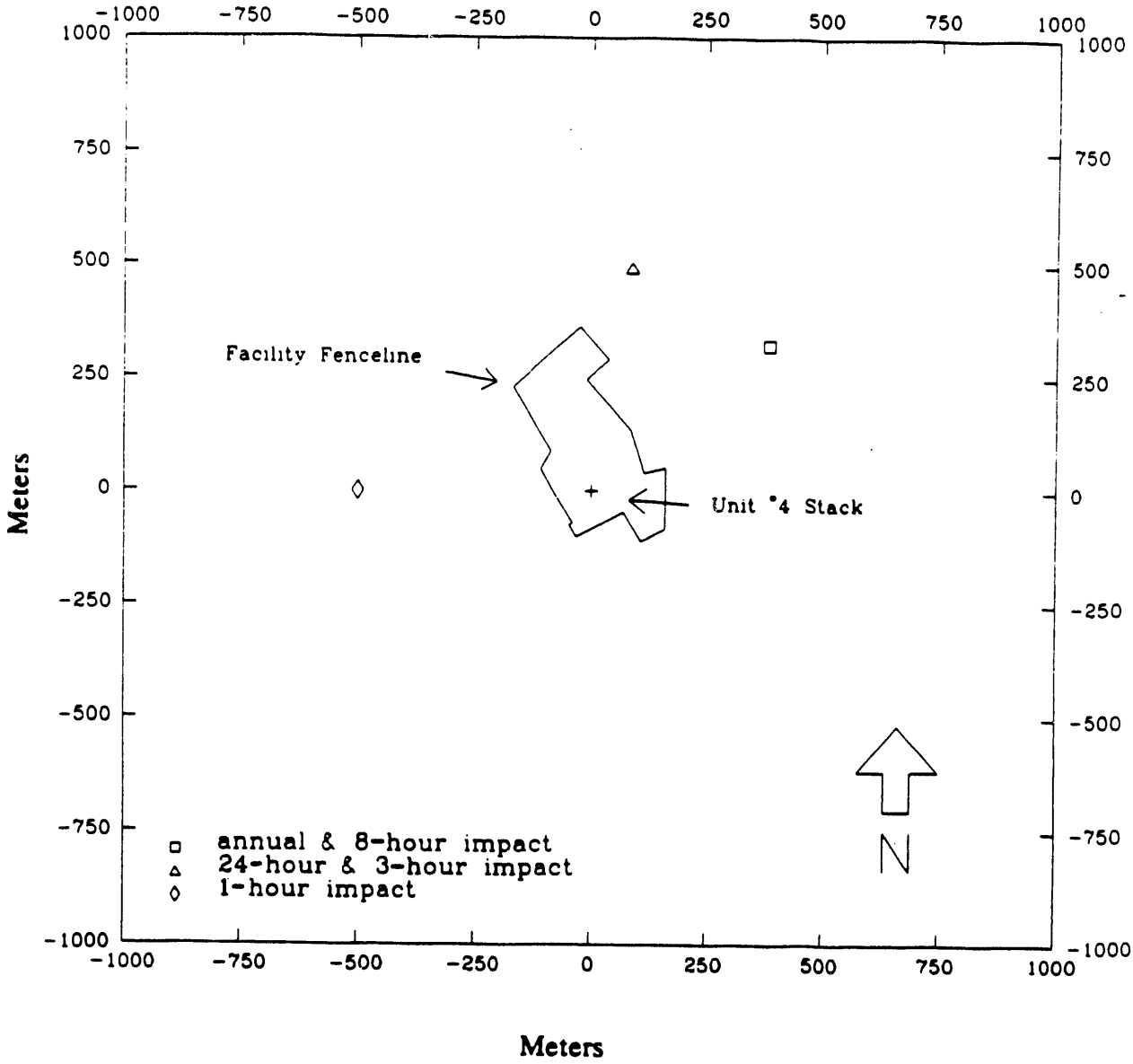

Figure 5-1. Modeled Impact Locations

NO_x, no increases exceeded 1.0 $\mu g/m^3$ for the annual average, therefore, no further evaluation was necessary for this pollutant. For SO_2, the annual average for the dolomitic lime/1.6 percent sulfur coal was less than the annualized average significance level. As demonstrated by Table 5-1, all other predicted SO_2 impacts exceed the significance levels for each averaging period for each injection period.

As outlined in October 1989 to January 1990 report, the methodology developed to determine compliance with the NAAQS was followed for SO_2 impacts with significant differences above the Baseline. The methodology requires an evaluation of existing air monitoring data. Monitoring data were obtained from U.S. Environmental Protection Agency (EPA) for two sites in Lorain, Ohio. The monitoring site best representing ambient background concentrations is located 6 km southeast of the Edgewater facility at 2270 East 42nd Street. The 42nd Street monitoring site is close enough to be representative of background concentrations for the Lorain area while its location is such that the monitored values include only a small contribution from the Unit 4 stack. Two years (1986 and 1987) of monitoring data were available from the East 42nd Street monitor. Table 5-2 summarizes the monitoring data provided by the Ohio EPA. The maximum annual value for the two years of data used is shown in this table. To determine background concentrations for an air quality analysis conducted using five years of meteorological data, the second highest monitored concentration is selected to determine compliance with the short term NAAQS (24-hour and 3-hour).

Table 5-2 provides the ground-level SO_2 concentration from monitoring and the total SO_2 concentration predicted by the ISCST model for the two sorbent/coal injection periods. The results of this analysis show that the SO_2 NAAQS standards were not exceeded during either of the injection periods modeled for this report. The highest impacts occurred during the dolomitic lime/3.0 percent sulfur coal injection period. During this injection period, the maximum 24-hour SO_2 impact was 80 percent (i.e., 293/365) of the NAAQS.

TABLE 5-2. AMBIENT AIR QUALITY MONITORING DATA AND MODEL PREDICTED IMPACTS

Averaging Period	SO_2 Ambient Monitored Value (μ/m^3)[b]	Monitored Year	Dolomitic Lime/ 1.6 Percent Sulfur Coal SO_2 Impacts ($\mu g/m^3$)	Dolomitic Lime/ 3.0 Percent Sulfur Coal SO_2 Impacts ($\mu g/m^3$)	Dolomitic Lime/ 1.6 Percent Sulfur Coal Expected Value ($\mu g/m^3$)	Dolomitic Lime/ 3.0 Percent Sulfur Coal Expected Value ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
Annual	23	1987	19	21	42 (53%)[c]	44 (55%)[c]	80
24 Hour[a]	83	1986	181	210	264 (72%)[c]	293 (80%)[c]	365
3 Hour[a]	411	1986	462	527	873 (67%)[c]	938 (67%)[c]	1300

[a]Highest second-highest impacts from 1986 and 1987 data.

[b]Monitor location is 2270 East 42nd Street, Lorain, Ohio.

[c]Percent of NAAQS.

5.2 Ground Water

No further definition of the environmental impact of fly ash disposal at the Kimble Landfill or Ohio Edison Ash Disposal Facility was possible during this period, since no additional ground-water monitoring data were generated.

6.0 HEALTH AND SAFETY

This section presents the findings of employee exposure (air and noise) monitoring conducted during this and the previous reporting periods. The purpose of the air sampling was to evaluate exposures during routine operation of the LIMB system to As and Pb (elements that tend to concentrate in the flyash), calcium oxide (CaO reported as Ca) (element that is added to control sulfur oxide emissions and subsequently appears in the flyash), and respirable silica (a component of flyash). Noise sampling was performed to determine if any additional employee exposures would occur from the operation of the LIMB system equipment.

6.1 Sampling Approach

The five positions listed below were selected for air sampling during a plant walkthrough on October 30, 1990.

- the B operator,
- the B auxiliary attendant (B-AT),
- the shift supervisor for the B operators,
- the yard operator for the No. 3 flyash silo, and
- the yard operator for the No. 4 flyash silo.

The yard operator for the No. 3 flyash silo was selected to establish a basis for comparing exposures during handling of regular flyash (No. 3 flyash silo) to handling lime-containing flyash (No. 4 flyash silo).

Three positions were selected for the noise monitoring program: the B operator, the B-AT operator, and their supervisor. From the screening results, three positions (the two flyash silo operators and the B-AT position) did not have significant noise exposures

during routine operations, although some of their maintenance tasks may have involved higher exposures. In addition, both positions were rarely exposed to the LIMB equipment during normal work. The screening results demonstrated that only the B operator should be selected for personal dosimetry.

The air sampling was performed according to National Institute of Occupational Safety and Health (NIOSH) sampling and analytical methods for As, Pb, CaO and respirable silica. One sampling method allowed for analysis of As, Pb and CaO on a single filter, while a second filter was used to collect respirable silica. For the noise assessment, a sound level meter was used as a screening instrument to identify the positions to sample, then was used in conjunction with personal sound dosimeters to evaluate the exposures and characterize noise sources.

Sampling episodes 1 and 3 (results for sampling episode 2 were in the May, June and July 1990 report) were conducted to better characterize exposures during routine operations. Sampling episode 1 began on Wednesday, October 31, 1990 and concluded Friday, November 2, 1990. Sampling episode 3 was performed on Friday, November 2, 1990, and Monday November 5, 1990 through Wednesday, November 7, 1990. Table 6-1 presents the sampling matrix implemented.

The original sampling plan was revised when the facility discontinued injecting lime on Thursday morning, November 1, 1990 due to blockage in the humidifier. Exposures of the No. 4 flyash silo operator to flyash containing lime continued through November 2, 1990. Additional samples were collected for this position on November 5 and 6, 1990 to represent exposures to regular flyash; thereby eliminating the need for the samples collected at the No. 3 flyash silo. These additional samples provided a more accurate comparison of exposures during the handling of regular and lime-containing flyash. The shutdown of the lime injection equipment reduced the exposure of the boiler operators to lime-containing flyash during episode 3. Flyash exposure is generally low during routine operations and the exposure reduction created by this shutdown is not

TABLE 6-1. SAMPLING SCHEDULE FOR EPISODES 1 AND 3

Position Sampled	Wednesday 10/31/90	Thursday 11/1/90	Friday 1/2/90	Monday 11/5/90	Tuesday 11/6/90	Wednesday 11/7/90
B operator	As, Ca, Pb (1) SiO_2 (1)	---	---	Noise Noise duplicate	As, Ca, Pb (3) SiO_2 (3)	Noise Noise duplicate
B-AT	As, Ca, Pb (1) SiO_2 (1)	---	---	[As, Ca, Pb] [As,Ca,Pb duplicate]	SiO_2 (3) SiO_2 duplicate	As, Ca, Pb (3)
Shift Supervisor	As, Ca, Pb (1) SiO_2 (1)	---	---	---	As, Ca, Pb (3) SiO_2 (3)	---
yard operator #4 flyash silo	As, Ca, Pb (1) As, Ca,Pb duplicate	SiO_2 (1) SiO_2 duplicate	SiO_2 (3) SiO_2 duplicate	As, Ca, Pb SiO_2	As, Ca, Pb As, Ca, Pb duplicate	As, Ca, Pb (3) As, Ca, Pb duplicate
yard operator #3 flyash silo	---	SiO_2 (3) SiO_2 duplicate	As, Ca, Pb (1) As, Ca, Pb duplicate	---	---	---
Area-wide sample (4th level, lime transport control panel)	SiO_2 SiO_2 duplicate	SiO_2 (#4 unit) SiO_2 (#3 unit)	SiO_2	SiO_2 SiO_2 duplicate	SiO_2	---

( ) sampling episode.
[ ] sampling done to collect a duplicate.
Note: Lime feed equipment was shut down on Thursday morning, 11/1/90; lime still in flyash through Friday, 11/2/90. Lime feed equipment restarted Tuesday morning, 11/6/90; lime in flyash by Wednesday afternoon, 11/7/90.

considered significant. Boiler operators also did not have to perform any maintenance during the shutdown. Shutdown maintenance occurs infrequently and therefore no significant effect from lime exposures is expected. During the shutdown the equipment was kept running, although the humidifier was bypassed. During this time, no difference in the noise levels was observed. Lime injection resumed on the afternoon of Wednesday, November 7, 1990.

6.2 Sampling Results

6.2.1 Air Samples

None of the positions received significant As, Pb, CaO or respirable silica exposures, as all the air sampling results were below the mass detection limits. Deriving the maximum concentration in air from the mass detection limits and the smallest volumes sampled, the comparison of the results to the PELs and the ACGIH TLVs shows them to be below respective standards and recommended limits, as shown in Table 6-2. From these results, the difference between exposures during regular boiler operations and exposures during use of the LIMB system cannot be determined. No conclusions can be drawn about exposures during shifts that differ from those sampled or non-routine activities.

6.2.2 Noise Monitoring

The sound level meter readings taken throughout episodes 1 and 3 characterize noise levels around the LIMB system equipment. The readings range between 81 and 97 decibels on the A-weighting scale (dBA) and are summarized in Table 6-3. The B operation is the position most affected by the LIMB equipment during routine operations. This position is required to make rounds every two hours that last about 10 minutes per round. Despite the high noise levels associated with the equipment, this short exposure duration reduces the potential for an overexposure to the OSHA PEL of

TABLE 6-2. EXPOSURE STANDARDS AND RESULTS

Compound	Mass Detection Limits (mg)	Maximum Concentration[a] (mg/m^3)	OSHA Permissible Exposure Limit (mg/m^3)[b]	ACGIH Threshold Limit Value (mg/m^3)[c]
Pb	0.002	0.004	0.05	0.15
As[d]	0.002	0.004	0.01	0.2
Ca	0.006	0.013	5	2
Quartz	0.01	0.022	--[e]	0.1

[a] Concentrations were calculated using the smallest value of air sample for that analyte. This conservative approach results in the finding that, even for the worst case sampled, exposures were below established standards.

[b] OSHA required.

[c] ACGIH recommended, 1990-1991.

[d] Soluble compounds as As.

[e] Not calculated because silica content was below detection limit.

TABLE 6-3. SUMMARY OF NOISE MEASUREMENTS

SOUND LEVEL METER READINGS		
LOCATION	LIMB Equipment (yes/no)	READING (dBA)
OSHA Action Level		85
OSHA PEL		90
Fan level:		
Elevator exit	N	82
Centac, NW side	Y	96
Centac control panel	Y	97
Compressed air dryer control panel	Y	91.5
Distribution bottle lines	Y	91
FD fan check	N	87.5
7th floor:		
Near top of day silo	Y	81.5
6th floor:		
Above fan	N	90
5th floor:		
Booster air fan startup	Y	86-92
Booster air fan check	Y	95
Top of stairs facing blowers	Y	87.5
North side of blower at 2 feet	Y	89-90
4th floor:		
Conveying air compressor	Y	88.5
Left Acrison feeder (Feeder A)	Y	83.5
Lime transport control panel	Y	81
3rd floor:		
Facing Fuller-Kenyon pump	Y	82
Control room entrance	N	85

DOSIMITER READINGS (8-hr, time-weighted average)	
11/5 B Operator	84-5 dBA (81.5 duplicate)
11/6 B Operator	87 dBA (81 duplicate)

90 dBA. For the days sampled, the B operator's exposure was between 81 and 87 dBA. With an OSHA action level of 85 dBA, the position should be considered for inclusion in a hearing conservation program. (The facility has already implemented a program that includes this position.)

Quantifying the contribution of the LIMB system to the B operator's exposure was not possible. The levels around the LIMB equipment are above background and some noise contribution is made; however, the position is exposed to noise from other sources, such as the turbine at the control room entrance, which raises the average exposure to 85 dBA.

The LIMB equipment produces noise at levels that may result in overexposures to individuals that do not wear hearing protection. Any work performed around the LIMB equipment, such as maintenance or repairs, should be done with hearing protection. For this reason, the LIMB equipment should be labelled as requiring the use of hearing protection and standard operating procedures implemented that require that work performed around LIMB equipment be done wearing hearing protection. In any event, the equipment should be discussed in the hearing conservation training as a high noise area.

7.0 COMPLIANCE MONITORING STATUS

Compliance monitoring is required for both gaseous and aqueous discharges. Opacity measurements, particulate emissions and SO_2 emissions estimates are required to meet source permit operation requirements. Particulate emission measurements are required once every 3 years. Opacity measurements are monitored continuously, and SO_2 emissions are to be estimated daily by using a coal sulfur content estimation method approved by the Ohio EPA. Table 7-1 presents the air compliance monitoring requirements for point sources at the facility. No compliance violations occurred for SO_2, opacity, or particulate loading during the November and December 1990, and January 1991 reporting period.

Tables 4-2 and 4-3 provide wastewater compliance monitoring limitations and measured pollutant parameters. No NPDES permit values were exceeded in wastewater samples collected by Radian or Ohio Edison personnel during this reporting period.

TABLE 7-1. SUMMARY OF CURRENTLY REQUIRED AIR COMPLIANCE MONITORING

Substance	Permit Level[a] (lb/MMBtu)	30-Day Weighted Rolling Average (lb/MMBtu)	Frequency of Monitoring	Averaging Approach	Monitoring Method	Duration of Monitoring[b] (years)
SO_2	3.4[c]	3.0 November 1990 2.7 December 1990 2.5 January 1991	Daily	30-day weighted rolling average	Analysis of a daily coal sample[d]	3
Opacity	20%[e]	5.0 November 1990 6.7 December 1990 1.1 January 1991	Continously	6-minute block average	In-situ opacity monitor	3
Particulate Loading	0.1	---	---	Average of 3 1-hour test runs	EPA Reference Method 5	3

[a] lb/MMBtu = pounds of pollutant emitted per 10^6 Btu actual heat input.

[b] The air permit from Ohio EPA is granted for 3 years.

[c] 30-day weighted, rolling average for entire plant, not just for boiler #13, Unit #4.

[d] A daily composite sample of the coal to be burned each day is collected according to ASTM D2234. The sample is analyzed for ash, sulfur, and heat content according to ASTM D3174, D3177, and D3015, respectively. The SO_2 emission rate is calculated from this analysis for each day, and a 30-day rolling weighted average SO_2 emission rate is calculated for each day.

[e] Up to 60 percent opacity is allowed for a duration of up to 6 minutes per hour. This regulation is applicable during start-up, once the flue gas temperature reaches 250°F at the ESP inlet.

8.0 QUALITY ASSURANCE/QUALITY CONTROL RESULTS

All air quality monitoring data utilized in this report were collected by the DAS and are statistically summarized in Table 4-1 and in Appendix A. All sampling and analytical procedures, sample custody, calibration procedures, data reduction and validation, reporting procedures, internal quality control checks, performance and system audits, preventative maintenance, assessment of precision, accuracy and completeness, and corrective action are detailed in the LIMB Demonstration Extension Quality Assurance Project Plan, August 1990.

All NPDES water quality data for Outfall 601 utilized in Table 4-3 and Appendix B are collected by Ohio Edison as a part of its permit requirements. QA/QC data for the pH, TSS, Flow, O&G, Total P, and As parameters are maintained by Ohio Edison personnel.

9.0 MONITORING PROBLEMS AND RECOMMENDATIONS FOR CHANGE

No monitoring equipment problems were encountered during the November and December 1990, and January 1991 reporting period. The data provided by the System 140 was extensively reviewed this reporting period to correct for highly repetitive data and extremely high SO_2 and NO_x values (lb/MMBtu). The highly repetitive data points were identified when the boiler was taken off-line (a period of minimal heat production). The System 140 would lock on to the last value while the system was off-line and repeat this value until the boiler and System were placed back on-line. In addition, erroneously high SO_2 and NO_x concentration values were recorded when CEM equipment would automatically clear the intake lines. Both the repetitive and erroneously high values were removed from the data used to calculate the daily averages.

APPENDIX A

DETAILED DAILY AVERAGE AIR EMISSIONS

DETAILED DAILY AVERAGE AIR EMISSIONS DATA

Date	Coal Rate Klb/hr	HHV Btu/lb	% S In Coal	Opacity %	SO2 Emissions lb/MMBtu	SO2 Emissions lb/hr*	SO2 Removal %	NOx Emissions lb/MMBtu	NOx Emissions lb/hr*
901101	52	12755	2.8	16	3.7	2449	25	0.39	256.3
901105	56	12790	2.8	7.4	3.1	2216	26	0.43	302.6
901106	80	12458	1.6	2.3	2.1	2044	26	0.47	469.2
901107	68	12560	1.5	2.3	2.1	1823	20	0.46	393.6
901108	69	12448	1.5	2.8	2.3	1994	24	0.43	368.7
901112	68	12674	1.5	2.2	2.9	2449	14	0.46	398
901113	62	12472	2.3	2.2	3.8	2948	32	0.46	358
901114	71	12631	2.8	3.7	3.7	3344	27	0.48	430.1
901115	69	12603	2.8	6.1	3.5	3083	30	0.44	379.9
901116	59	12679	2.8	2.7	3.6	2697	28	0.41	304.2
901117 **	48	12709	2.8	3.1	3.0	1863	38	0.35	218.2
901119	72	12738	2.2	2.4	2.5	2264	38	0.44	408.2
901120	70	12557	1.7	5.2	2.1	1835	31	0.43	381.8
901121	86	12494	1.5	6.6	2.2	2326	23	0.43	463.1
901126	45	12324	1.5	4.2	2.3	1294	18	0.37	203.3
901127	45	12533	1.9	5.6	2.7	1550	28	0.38	215.1
901128	67	12612	3.0	5.6	3.8	3199	23	0.41	346.4
901129	63	12721	3.5	6.5	4.3	3425	27	0.42	333.5
901130	62	12597	3.4	7.4	3.9	3030	39	0.36	283.2
Average	64	12598	2.3	5.0	3.0	2412	27	0.42	342.9
Maximum	86	12790	3.5	16	4.3	3425	39	0.48	469.2
Minimum	45	12324	1.5	2.2	2.1	1294	14	0.35	203.3
901202 **	70	12628	3.4	7.0	6.0	5306	7.7	0.45	398.4
901203	66	12658	3.4	8.7	4.5	3755	26	0.48	399.4
901204	64	12642	3.7	7.4	4.3	3452	36	0.41	332.6
901205	66	12614	2.6	9.0	2.3	1924	46	0.42	353.0
901206	58	12530	2.0	13	2.9	2078	21	0.43	312.1
901207	66	12505	1.9	14	2.4	1983	28	0.42	349.0
901208 **	41	12551	1.9	14	2.6	1357	21	0.41	212.2
901210	40	12597	1.9	8.9	2.4	1211	28	0.41	210.4
901211	45	12513	1.7	0.76	2.3	1309	29	0.42	240.6
901212	40	12427	1.7	3.6	2.2	1117	33	0.43	217.6
901213	61	12162	1.8	11	2.1	1567	35	0.48	359.0
901214	54	12475	1.6	6.2	2.3	1525	24	0.43	288.7
901215 **	31	12551	1.5	3.8	2.1	840.4	23	0.41	159.7
901217	53	12626	1.6	1.8	2.1	1412	29	0.41	270.7
901218	46	12387	1.5	1.5	2.0	1176	28	0.39	222.8
901219	49	12442	1.5	1.9	1.8	1119	35	0.40	246.7
901220	62	12372	1.5	5.3	1.8	1379	35	0.44	336.1
901221 **	23	12430	1.5	1.8	1.8	522.7	36	0.35	99.3
Average	52	12506	2.0	6.7	2.7	1835	29	0.42	278.2
Maximum	70	12658	3.7	14.1	6.0	5306	46	0.48	399.4
Minimum	23	12162	1.5	0.76	1.8	522.7	7.7	0.35	99.30

DETAILED DAILY AVERAGE AIR EMISSIONS DATA (continued)

Date	Coal Rate Klb/hr	HHV Btu/lb	% S In Coal	Opacity %	SO2 Emissions lb/MMBtu	SO2 Emissions lb/hr*	SO2 Removal %	NOx Emissions lb/MMBtu	NOx Emissions lb/hr*
910101 **	54	12430	1.5	0.93	2.4	1612	14	0.42	287.8
910102	69	12487	1.5	0.68	2.5	2184	9.4	0.43	368.2
910103	75	12384	1.5	0.89	2.5	2280	10	0.43	398.8
910104	61	12486	1.6	0.80	2.5	1951	19	0.42	318.6
910107	49	12447	1.6	0.95	2.5	1558	12	0.40	247.4
910108	52	12481	1.6	1.1	2.6	1669	13	0.38	244.8
910109	54	12664	1.6	1.2	2.5	1696	27	0.40	272.1
910110	66	12651	1.6	0.94	2.8	2324	12	0.43	359.1
910111	48	12408	1.7	1.1	2.6	1557	25	0.41	242.3
910114	43	12498	1.6	1.0	2.7	1478	9.4	0.38	204.2
910115	46	12473	1.6	1.4	2.5	1457	23	0.38	219.1
910117	73	12404	1.5	1.3	2.6	2315	14	0.44	398.6
910118	58	12493	1.5	1.5	2.5	1859	11	0.43	315.3
910121	55	12541	1.5	1.5	2.6	1787	21	0.42	293.3
910122	71	12572	1.7	1.5	2.9	2591	9	0.45	407.0
910124	74	12650	1.6	3.1	2.7	2523	14	0.48	450.0
910125	63	12306	1.6	2.0	2.8	2178	19	0.44	338.5
910128	65	12436	1.6	1.4	2.6	2135	14	0.43	352.0
910129	64	12324	1.5	1.3	2.5	1974	11	0.44	351.7
910130	69	12439	1.5	1.1	2.4	2064	15	0.43	372.7
910131	74	12180	1.5	1.8	2.5	2270	20	0.44	400.6
Average	61	12464	1.6	1.3	2.6	1974	15	0.42	325.8
Maximum	75	12664	1.7	3.1	2.9	2591	27	0.48	450.0
Minimum	43	12180	1.5	0.7	2.4	1457	9	0.38	204.2
LIMB Extension: November and December 1990 and January 1991 Reporting Period									
AVERAGE	59	12523	2.0	4.3	2.8	2074	24	0.42	315.7
Baseline Period: February 17, 1990 through April 23, 1990									
AVERAGE	53	11680	1.3	1.3	1.4	932	NA	0.28	181.0

HHV = Higher Heating Value

These values calculated as: lbs/hr=((lbs/mmBtu)(Klb/hr)(Btu/lb)(1000lb/Klb)/(10E6Btu/mmBtu))

**The HHV reported for this day is an average of the preceding and following day.

APPENDIX B

601 OUTFALL COMPLIANCE REPORTS

OHIO EDISON COMPANY | STATION CODE 3120000560 | DATE (MONTH, YEAR) NOV.-90 | PAGE NUMBER OF PRINTED 1 1 OF 12/7/90 | APPLICATION OH0000523

EDGEWATER PLANT
76 SOUTH MAIN STREET
AKRON 44308 LORAIN

SAMPLING STATION DESCRIPTION
601 ASH POND DISCHARGE PRIOR TO ENTERING LAKE ERIE

NOTE THIS FORM MUST BE TY

IN(1) ENTER 1 FOR CONTINUOUS 2 FOR COMPOSITE 3 FOR GRAB SAMPLE
IN(2) ENTER FREQUENCY OF SAMPLING

REPORTING LAB: ENVIROMATRIX
ANALYST: S. HILL

DAY AND CODE NO AT RIGHT	(1)	3	3	3	3	3					
	(2)	1	1	1	1	1					
		PH S.U.	RESIDU T. NFL MG/L GROSS	CONDUI FLOW MGD	O&G FREN-G MG/L	ARSENI AS,TOT UG/L					
		REPORTING CODE	REPORTING CODE	REPORTING CODE	REPORTING CODE	REPORTING CODE	REPORTING CODE	REPORTING CODE	REPORTING CODE	REPORTING CODE	REPORTING
DAY		00400	00530	50050	00556	01002					
01		8.0	2	1.3							
02				1.6							
03				1.6							
04				1.6							
05				1.2							
06		7.8	3	1.2							
07				1.2							
08		7.7	11	1.2							
09				1.6	3	162					
10				1.6							
11				1.6							
12				1.5							
13		7.8	12	1.5							
14				1.6							
15		7.4	8	1.6							
16				1.6							
17				1.6							
18				1.6							
19				1.6							
20		7.7	5	1.6							
21		7.1	15	1.9							
22				1.6							
23				1.2							
24				1.2							
25				1.6							
26				1.6							
27				1.6							
28		7.6	7	1.6							
29				1.6							
30		8.3	8	1.6							
31											
TOTAL			71	45.4	3	162					
AVG			8	1.5	3	162					
MAX		8.8	15	1.6	3	162					
MIN		7.1	2	1.2	3	162					

ADDITIONAL REMARKS (ALL REPORTING CODES MUST BE EXPLAINED IN THIS SECTION)

DISTRIBUTION
WHITE - AGENCY
YELLOW - AGENCY
GREEN - REPORTER
FORM NO. EPA 4500 (8-86)
FORMERLY EPA SUR 1

I CERTIFY UNDER THE PENALTY OF LAW THAT I HAVE PERSONALLY EXAMINED AND AM FAMILIAR WITH THE INFORMATION SUBMITTED AND BASED ON MY INQU THOSE INDIVIDUALS IMMEDIATELY RESPONSIBLE FOR OBTAINING THE INFORMATION, I BELIEVE THE SUBMITTED INFORMATION IS TRUE, ACCURATE AND COMPLET AWARE THAT THERE ARE SIGNIFICANT PENALTIES FOR [illegible] INFORMATION, INCLUDING THE POSSIBILITY OF FINE AND IMPRISONMENT.

DATE REPORT COMPLETED	SIGNATURE O		TITLE OF REPORTER
12/7/90			Plant Superintendent

8510 M 9008 850926

4500

MONTHLY REPORT FORM

OHIO EDISON COMPANY 3IB00005601 DEC.-90 2 2 1-11-91 OH005

EDGEWATER PLANT
76 SOUTH MAIN STREET
AKRON 44308 LORAIN

601 ASH POND DISCHARGE PRIOR TO ENTERING LAKE ERIE

FORM

EDGEWATER S. HILL

	3 1 CHROM HEX-VA UG/L 01034	3 1 CHROM CR,TOT UG/L 01034	3 1 NICKEL TOT,RE UG/L 01074	3 1 SILVER TOT,RE UG/L 01079	3 1 ZINC TOT,RE UG/L 01094	3 1 LEAD CP TOT,RE UG/L 01114	3 1 MERCUR TOT,RE UG/L 71901
01							
02							
03							
04							
05	5	20	40	0.1	10	1.0	0.1
06							
07	Bus	50	50	50	5000	50	1.1
08	ug/L)						
09							
10							
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25							
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27							
28							
29							
30							
31							
	5	20	40	0.1	10	1.0	0.1
	5	20	40	0.1	10	1.0	0.1
	5	20	40	0.1	10	1.0	0.1
	5	20	40	0.1	10	1.0	0.1

AGENCY

1_11_91

4500

MONTHLY REPORT FORM

OHIO EDISON COMPANY

3IB00005601 DEC.-90 1 2 1-11-91

EDGEWATER PLANT
76 SOUTH MAIN STREET
AKRON 44308 LORAIN

601 ASH POND DISCHARGE PRIOR TO ENTERING LAKE ERIE

FORM

EDGEWATER S. HILL

	3 1 PH S.U.	3 1 RESIDU T. NFL MG/L GROSS	3 1 CONDUI FLOW MGD	3 1 O&G FREN-G MG/L	3 1 ARSENI AS,TOT UG/L	3 1 CYANID FREE MG/L	3 1 ARSENI TOT,RE UG/L	3 1 SELENI TOT,RE UG/L	3 1 BERYL BE,TOT UG/L
	00400	00530	50050	00556	01002	00719	00978	00981	01012
01			1.6						
02			1.6						
03			1.7						
04			1.6						
05	7.8	8	1.6			0.005	36	2	0.1
06	7.7	22	1.3		OWS	0.154 mg/l	50	10	
07			1.3						
08			1.6						
09			1.6						
10			1.3	AA	58				
11	8.0	18	1.1						
12			1.6		OWS 50				
13	7.5	2	1.1						
14			1.1						
15			1.6						
16			1.6						
17			1.6						
18	7.4	4	1.6						
19	8.3	3	1.1						
20			1.6						
21			1.7						
22			1.3						
23			1.3						
24			1.2						
25			1.3						
26			1.2						
27	7.2	6	0.9						
28	7.4	8	1.1						
29			1.2						
30			1.1						
31			1.1						
Total		71	42.6	AA	58	0.005	36	2	0.1
Avc		9	1.4	AA	58	0.005	36	2	0.1
Max.	8.3	22	1.7	AA	58	0.005	36	2	0.1
Min.	7.2	2	0.9	AA	58	0.005	36	2	0.1

AA: Below detectable limits.

AGENCY

1.11.91

Plant Superintendent

8510 M 9008 850926

4500

NTHLY REPORT FORM

OHIO EDISON COMPANY 3IB00005601 JAN-91 1 1 2-5-91 OH0005130

EDGEWATER PLANT
76 SOUTH MAIN STREET
AKRON, OH 44308 LORAIN

601 ASH POND DISCHARGE PRIOR TO ENTERING LAKE ERIE

FORM

EDGEWATER S. HILL

	3 1 PH S.U. 00400	3 1 RESIDUE T. NFL MG/L GROSS 00530	3 1 CONDUI FLOW MGD 50050	3 1 O&G FREN-G MG/L 00556	3 1 ARSENI AS,TOT UG/L 01002
01			1.1		
02			1.1		
03	7.1	10	1.1		
04	7.4	10	1.5		
05			1.3		
06			1.1		
07			1.3		
08	7.0	20	1.3		
09			1.1		
10	7.2	4	1.1		
11			0.9		
12			1.1		
13			1.3		
14			1.1		
15	7.4	6	0.9		
16			1.1	2	53
17	7.6	8	1.1		
18			1.3		
19			1.5		
20			1.3		
21			1.3		
22			1.1		
23	7.2	29	0.7		
24	7.6	16	0.7		
25			0.9		
26			1.1		
27			1.1		
28			1.3		
29	7.5	11	1.3		
30	7.4	5	1.1		
31			1.1		
		119	35.3	2	53
		12	1.1	2	53
	7.6	29	1.5	2	53
	7.0	4	0.7	2	53

APPENDIX C

601 OUTFALL DAILY pH AND SAMPLE LOG

FIELD SAMPLE I.D.	DATE/TIME	SAMPLE MATRIX	DATE SHIPPED
LIMB - EMP6Ø1 - Ø1	1-22-9Ø TO 1-26-9Ø	H_2O / HNO_3	2-2Ø-9Ø AU
LIMB - EMP6Ø1 - Ø2	1-27-9Ø TO 2-5-9Ø	↓	↓
LIMB - EMP6Ø1 - Ø3	2-1Ø-9Ø TO 2-6-9Ø		
LIMB - EMP6Ø1 - Ø4	2-11-9Ø TO 2-15-9Ø		
LIMB - EMP6Ø1 - Ø5	2-16-9Ø		
LIMB - EMP6Ø1 - Ø6	2-16-9Ø	H_2O BLANK	
LIMB - EMP ASH - Ø1	1-22-9Ø TO 2-16-9Ø	ASH SOLIDS	3-1-9Ø AU
LIMB - EMP6Ø1 - Ø7	3-1-9Ø TO 4-16-9Ø	H_2O/HNO_3	5-15-9Ø AU
LIMB - EMPASH - Ø2	3-1-9Ø TO 4-16-9Ø	ASH SOLIDS	5-15-9Ø AU
LIMB - EMP6Ø1 - Ø8	4-3Ø-9Ø TO 5-25-9Ø	H_2O/HNO_3	7-23-90
LIMB - EMPASH - Ø3	4-3Ø-9Ø TO 5-25-9Ø	ASH SOLIDS	7-23-90
LIMB - EMP6Ø1 - Ø9	6-1-9Ø TO 6-15-9Ø	H_2O/HNO_3	7-23-90
LIMB - EMPASH - Ø4	6-1-9Ø TO 6-15-9Ø	ASH SOLIDS	7-23-90
LIMB - EMPASH - Ø5	6-19-90 TO 7-16-90	ASH	7-23-90
LIMB - EMP6Ø1 - 10	6-19 TO 6-29-90	H_2O / HNO_3	7-23-90
LIMB - EMP6Ø1 - 11	7-2-90 TO 7-16-90	"	7-23-90
LIMB - EMPASH - 06	4-30-90 TO 5-25-90	Duplicate of LIMB - EMPASH - Ø3	7-23-90
LIMB - EMP6Ø1 - 12	10-8-90 TO 10-12		~~1-8-9~~
- 13	10-15 TO 10-18		
- 14	10-22 TO 10-29		
LIMB - EMP6Ø1 - 15	10-29 TO 10-31		1-8-91
- 16	11-12 TO 11-16		
- 17	11-26 TO 11-30		
LIMB - EMPASH - 07	10-8 TO 11-27	medium % S Dolomitic Lime	
- EMP ASH - 08	11-28 TO 12/20	~~Low~~ % S Dolomitic Lime	
LIMB - EMP6Ø1 - 18	12-3-90 TO 12-7-90		
- 19	12/10 TO 12/14		
- 20	12-17 TO 12/21		
- 21	1/7 TO 1/11	Limestone / low S coal	
- 22	1/14 TO 1/18	" "	

To Page No. _____

Witnessed & Understood by me, Date _____ led by _____ Date _____

_____ ded by

RADIAN CORPORATION Project No. Book No 22652 TITLE _____

DATE	LOAD (MWe)	COAL/SORBENT COMBINATION	INJECTION/ HUMIDIFICATION STATUS	Ca/S RATIO	pH	SAMPLES TAKEN Ca	SAMPLES TAKEN ASH	C	INITIALS
11-6-90		Low % S Dolomitic Lime	15		7.74			15.1	1030 RR
11-12-90		Med % S Dolomitic lime	30		7.21	✓	✓	11.0	1100 RR
11-13-90					7.26	✓	✓	10.6	1100 RR
11-14-90					6.66	✓	✓	13.0	1300 RR
11-15-90					7.15	✓	✓	15.2	1300 RR
11-16-90					7.42	✓	✓	15.4	1100 RR
11-26-90		L%S/DLime			7.35	✓	✓	10.8	1300 RR
11-27					7.06	✓	✓	14.9	1300 RR
11-28		H%S/DLime			7.21	✓	✓	13.3	1230 RR
11-29		H%S/DLime			7.72	✓	✓	12.7	1300 RR
11-30-90		H%S/Dlime			8.38	✓	✓	10.9	1300 RR
12-3-90		H%S/D.lime			7.32	✓	✓	9.6	1400 RR
12-4-90		"			7.63	✓	✓	8.3	1230 RR
12-5-90		L%S/D.lime			7.51	✓	✓	9.5	1430 RR
12-6-90		L/D			7.28	✓	✓	11.2	1300 RR
12-7-90		L%S/D.lime			7.34	✓	✓	12.1	1330 RR
12-10-90		L%S/Dlime			7.23	✓	✓	11.5	1300 RR
12-11-90		L%S/Dlime			7.36	✓	✓	11.0	1300 RR
12-12-90		L%S/Dlime			7.27	✓	✓	12.0	1100 RR
12-14-90		L%S/D.lime			7.55			11.4	1400 RR
12-17-90		L%S/Dlime			7.73	✓	✓	10.5	1300 RR
12-19-90					7.78	✓	✓	11.0	1400 RR
12-20					7.37			11.5	1300 RR
12-21					7.52			11.2	1300 RR

To Page No. _____

Witnessed & Understood by me. Date

d by Date

DATE	LOAD (MWe)	COAL/SORBENT COMBINATION	INJECTION/ HUMIDIFICATION STATUS	Ca/S RATIO	pH	SAMPLES TAKEN Ca	ASH	C	INITIALS
1-7-91		L/S, Limestone			7.24		✓	9.6	1300
1-8-91		"			6.97		✓	10.3	1400
1-9-91		"			7.12			8.3	1400
1-10-91		"			7.26		✓	7.5	1400
1-11-91		"			7.15		✓	6.9	1400
1-14-91		"			7.13		✓	5.8	1000
1-15-91					7.45			10.1	1330
1-17-91					7.15		✓	9.6	1400
1-18-91					7.07		✓	5.8	1100
1-21-91					7.10		✓	7.5	1300
1-22-91		L/S / Fine Limestone			7.13		✓	8.0	1400
1-23-91		"			7.07			7.2	1430

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Witnessed & Understood by me, Date by Date

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APPENDIX D

601 CALCIUM ANALYSIS

rec. 1/.8/91
LGC

RADIAN
CORPORATION

Radian Work Order 91-01-069

Analytical Report
01/15/91

Babcock and Wilcox Co.

Radian
RTP
MC

Luke Contos

Customer Work Identification LIMB PROJECT
Purchase Order Number 209-026-05-00

Contents:

Radian Analytical Services
8501 Mo-Pac Boulevard
P. O. Box 201088
Austin, TX 78720-1088

512/454-4797

Client Services Coordinator: KAYOUNG

Certified by: Randy Clark

RADIAN CORPORATION

Analytical Data Summary

Babcock and Wilcox Co.
Radian Work Order: 91-01-069

Method/Analyte	Sample Identifications		
	LIMB-EMP601-15	LIMB-EMP601-16	LIMB-EMP601-17
	01	02	03
Matrix	water	water	water
	Result Det. Limit	Result Det. Limit	Result Det. Limit
Calcium by ICPES SW6010			
Calcium	83 mg/L 1.0	57 mg/L 1.0	43 mg/L 1.0

(1) For a detailed description of flags and technical terms in this report refer to the glossary.

RADIAN CORPORATION

Analytical Data Summary

Babcock and Wilcox Co.
Radian Work Order: 91-01-069

Method/Analyte	Sample Identifications	
	LIMB-EMP601-18	METHOD BLANK
	04	05
Matrix	water	water

	Result	Det. Limit	Result	Det. Limit
Calcium by ICPES SW6010				
Calcium	59 mg/L	1.0	ND mg/L	1.0

ND Not detected at specified detection limit

(1) For a detailed description of flags and technical terms in this report refer to the glossary.

Babcock and Wilcox Co.
Radian Work Order: 91-01-069

Sample Identifications and Dates

Sample ID	LIMB-EMP601-15	LIMB-EMP601-16	LIMB-EMP601-17	LIMB-EMP601-18	METHOD BLANK	
Date Sampled	01/07/91	01/07/91	01/07/91	01/07/91		
Date Received	01/09/91	01/09/91	01/09/91	01/09/91	01/09/91	
Matrix	water	water	water	water	water	
	01	02	03	04	05	
Calcium by ICPES SW6010						
Prepared	01/10/91	01/10/91	01/10/91	01/10/91	01/10/91	
Analyzed	01/11/91	01/11/91	01/11/91	01/11/91	01/11/91	
Analyst	DES	DES	DES	DES	DES	
File ID						
Blank ID						
Instrument	JA61	JA61	JA61	JA61	JA61	
Report as	received	received	received	received	received	

Appendix A

Comments, Notes and Definitions

ND ALL METHODS EXCEPT CLP

This flag is used to denote analytes which are not detected at or above the specified detection limit.

EXPLANATION

The value to the right of the < symbol is the method specified detection limit for the analyte.

Babcock and Wilcox Co.
Radian Work Order: 91-01-069

TERMS USED IN THIS REPORT:

Analyte - A chemical for which a sample is to be analyzed. The analysis will meet EPA method and QC specifications.

Compound - See Analyte.

Detection Limit - The method specified detection limit, which is the lower limit of quantitation specified by EPA for a method. Radian staff regularly assess their laboratories' method detection limits to verify that they meet or are lower than those specified by EPA. Detection limits which are higher than method limits are based on experimental values at the 99% confidence level. The detection limits for EPA CLP (Contract Laboratory Program) methods are CRQLs (contract required quantitation limits) for organics and CRDLs (contract required detection limits) for inorganics. Note, the detection limit may vary from that specified by EPA based on sample size, dilution or cleanup. (Refer to Factor, below)

EPA Method - The EPA specified method used to perform an analysis. EPA has specified standard methods for analysis of environmental samples. Radian will perform its analyses and accompanying QC tests in conformance with EPA methods unless otherwise specified.

Factor - Default method detection limits are based on analysis of clean water samples. A factor is required to calculate sample specific detection limits based on alternate matrices (soil or water), reporting units, use of cleanup procedures, or dilution of extracts/digestates. For example, extraction or digestion of 10 grams of soil in contrast to 1 liter of water will result in a factor of 100.

Matrix - The sample material. Generally, it will be soil, water, air, oil, or solid waste.

Radian Work Order - The unique Radian identification code assigned to the samples reported in the analytical summary.

Units -	ug/L	micrograms per liter (parts per billion);liquids/water
	ug/kg	micrograms per kilogram (parts per billion); soils/solids
	ug/M3	micrograms per cubic meter; air samples
	mg/L	milligrams per liter (parts per million);liquids/water
	mg/kg	milligrams per kilogram (parts per million);soils/solids
	%	percent; usually used for percent recovery of QC standards
	uS/cm	conductance unit; microSiemens/centimeter
	mL/hr	milliliters per hour; rate of settlement of matter in water
	NTU	turbidity unit; nephelometric turbidity unit
	CU	color unit; equal to 1 mg/L of chloroplatinate salt

RADIAN
CORPORATION

Radian Work Order 91-02-046

Analytical Report
02/11/91

Babcock and Wilcox Co.

Radian
RTP
NC

Luke Contos

Customer Work Identification LIMB PROJECT
Purchase Order Number 209-026-05-00

Contents:

Radian Analytical Services
8501 Mo-Pac Boulevard
P. O. Box 201088
Austin, TX 78720-1088

512/454-4797

Client Services Coordinator: KAYOUNG

Certified by:

Babcock and Wilcox Co.
Radian Work Order: 91-02-046

Method/Analyte	Sample Identifications		
	LIMB-EMP601-19	LIMB-EMP601-20	LIMB-EMP601-21
	01	02	03
Matrix	water	water	water
	Result Det. Limit	Result Det. Limit	Result Det. Limit
Calcium by ICPES SW6010			
Calcium	50 mg/L 1.0	40 mg/L 1.0	42 mg/L 1.0

(1) For a detailed description of flags and technical terms in this report refer to the glossary.

Babcock and Wilcox Co.
Radian Work Order: 91-02-046

Method/Analyte	Sample Identifications			
	LIMB-EMP601-22		METHOD BLANK	
	04		05	
Matrix	water		water	
	Result	Det. Limit	Result	Det. Limit
Calcium by ICPES SW6010				
Calcium	44 mg/L	1.0	ND mg/L	1.0

ND Not detected at specified detection limit

(1) For a detailed description of flags and technical terms in this report refer to the glossary.

Babcock and Wilcox Co.
Radian Work Order: 91-02-046

Sample Identifications and Dates

Sample ID	LIMB-EMP601-19	LIMB-EMP601-20	LIMB-EMP601-21	LIMB-EMP601-22	METHOD BLANK
Date Sampled	02/05/91	02/05/91	02/05/91	02/05/91	
Date Received	02/06/91	02/06/91	02/06/91	02/06/91	02/06/91
Matrix	water	water	water	water	water
	01	02	03	04	05
Calcium by ICPES SW6010					
Prepared	02/07/91	02/07/91	02/07/91	02/07/91	02/07/91
Analyzed	02/07/91	02/07/91	02/07/91	02/07/91	02/07/91
Analyst	DES	DES	DES	DES	DES
File ID					
Blank ID					
Instrument	JA61	JA61	JA61	JA61	JA61
Report as	received	received	received	received	received

Appendix A

Comments, Notes and Definitions

Babcock and Wilcox Co.
Radian Work Order: 91-02-046

ND ALL METHODS EXCEPT CLP

This flag is used to denote analytes which are not detected at or above the specified detection limit.

EXPLANATION

The value to the right of the < symbol is the method specified detection limit for the analyte.

Babcock and Wilcox Co.
Radian Work Order: 91-02-046

TERMS USED IN THIS REPORT:

Analyte - A chemical for which a sample is to be analyzed. The analysis will meet EPA method and QC specifications.

Compound - See Analyte.

Detection Limit - The method specified detection limit, which is the lower limit of quantitation specified by EPA for a method. Radian staff regularly assess their laboratories' method detection limits to verify that they meet or are lower than those specified by EPA. Detection limits which are higher than method limits are based on experimental values at the 99% confidence level. The detection limits for EPA CLP (Contract Laboratory Program) methods are CRQLs (contract required quantitation limits) for organics and CRDLs (contract required detection limits) for inorganics. Note, the detection limit may vary from that specified by EPA based on sample size, dilution or cleanup. (Refer to Factor, below)

EPA Method - The EPA specified method used to perform an analysis. EPA has specified standard methods for analysis of environmental samples. Radian will perform its analyses and accompanying QC tests in conformance with EPA methods unless otherwise specified.

Factor - Default method detection limits are based on analysis of clean water samples. A factor is required to calculate sample specific detection limits based on alternate matrices (soil or water), reporting units, use of cleanup procedures, or dilution of extracts/digestates. For example, extraction or digestion of 10 grams of soil in contrast to 1 liter of water will result in a factor of 100.

Matrix - The sample material. Generally, it will be soil, water, air, oil, or solid waste.

Radian Work Order - The unique Radian identification code assigned to the samples reported in the analytical summary.

Units -	ug/L	micrograms per liter (parts per billion);liquids/water
	ug/kg	micrograms per kilogram (parts per billion); soils/solids
	ug/M3	micrograms per cubic meter; air samples
	mg/L	milligrams per liter (parts per million);liquids/water
	mg/kg	milligrams per kilogram (parts per million);soils/solids
	%	percent; usually used for percent recovery of QC standards
	uS/cm	conductance unit; microSiemens/centimeter
	mL/hr	milliliters per hour; rate of settlement of matter in water
	NTU	turbidity unit; nephelometric turbidity unit
	CU	color unit; equal to 1 mg/L of chloroplatinate salt

APPENDIX E

AMBIENT AIR MODELING PROTOCOL

5.0 AMBIENT MONITORING

5.1 Air

Air dispersion modeling will be used to assess the relative change in maximum ground level pollutant concentrations for Unit 4. The maximum predicted ground level concentration will be determined from the baseline operating conditions for Unit 4 during normal firing conditions with no sorbent injection (firing coal with a 1.8% sulfur content) and for each of the coal/sorbent scenarios that will be evaluated in the Coolside and LIMB Extension studies. The pollutant emissions evaluated will include SO_2, NO_x, PM/PM_{10}, and CO. The averaging periods that will be predicted for each pollutant will correspond with those for which a National Ambient Air Quality Standard (NAAQS) has been established.

In most cases, reductions in predicted maximum ground level pollutant concentrations are expected to occur since Unit 4 emissions levels will decrease compared to baseline levels. If increases in maximum concentrations over the baseline case are predicted, a further evaluation will be conducted to determine if the NAAQS will be exceeded. No additional ambient air monitoring will be conducted during the demonstation study.

The following methodology will be used in this study:

1. Define the baseline emissions case. AP-42 emissions factors will be used to determine emissions of SO_2, NO_x, CO, and PM/PM_{10} from Unit 4 firing 1.8% sulfur coal if stack data are not available. Representative stack parameters (stack exit temperature and flowrate) for the maximum firing rate of Unit 4 will be derived from existing stack test data for the period when Unit 4 was firing 1.8% sulfur coal.

2. Determine the maximum baseline ground level concentration. The maximum predicted annual average and short term average off-property concentrations from Unit 4 will be determined for the baseline emissions case. The modeling analysis will be conducted using five years of meteorological

data and an EPA approved air dispersion model ISCST Version 88348. Additional discussion of the model methodolgy is presented below.

3. Define the emissions case for each coal/sorbent scenario. New stack parameter and emissions data for Unit 4 will be developed from the actual data collected from CEM monitoring and from Method 5 testing during the demonstration project.

4. Determine the maximum ground level concentration for a new scenario. The maximum predicted annual average and short term average off property concentrations from Unit 4 will be determined for each coal/sorbent emissions case. The modeling methodology and model inputs used to determine the maximum concentrations will be identical to those used in (2) and discussed below.

5. Compare the maximum concentrations predicted in (2) and (4). The results of the modeling analyses conducted in (2) and (4) will be compared to determine the increase (or decrease) in the predicted maximum ground level concentration for each pollutant and averaging period. In some cases, the maximum predicted concentration for the baseline and coal/sorbent case will occur at different receptors for the same pollutant and averaging period because of the differences in stack exit temperature or flowrate. For these cases, the maximum predicted concentration for the baseline case and the coal/sorbent cases will be determined at the maximum receptor location determined for each case, and the maximum difference reported.

If the difference in maximum predicted concentration from the new coal/sorbent case compared to the baseline case that was determined in (5) for all pollutants and averaging periods result in concentration decreases, no further evaluation will be necessary. Otherwise, the following analysis will be performed:

6. The magnitude of the increase for each pollutant and averaging period predicted in (5) will be compared to the ambient air significance levels as defined in the Prevention of Significant Deterioration air regulations (40 CFR 51.165 b(2)). For the pollutants evaluated in this study,

these values are 1 $\mu g/m^3$ (SO_2, PM/PM_{10}, NO_x) for the annual average, 5 $\mu g/m^3$ (SO_2, PM/PM_{10}) for the 24-hour average, 25 $\mu g/m^3$ (SO_2) for the 3-hour average, 500 $\mu g/m^3$ (CO) for the 1-hour average, and 2000 $\mu g/m^3$ (CO) for the 8-hour averaging period. By definition, if the concentration is less than the significance level, a source is not considered to cause or contribute to a violation of the national air quality standard. If the increase in concentration predicted in (5) for a given pollutant and averaging period is significant, the existing ambient air monitoring will be reviewed and the need for collection of additional monitoring data will be evaluated.

5.1.1 Model Selection

The estimates of ambient air quality concentrations will be based on the applicable air quality model and techniques as specified in the EPA Guideline on Air Quality Models. The EPA approved version of the Industrial Source Complex model (ISCST version 88348) will be used in the modeling analysis.

5.1.2 Meteorological Data

Five years (1981-1985) of meteorological data will be used in the analysis. The surface data were recorded at Hopkins International Airport in Cleveland, Ohio, and the upper-air data were recorded at Buffalo International Airport in Buffalo, New York. These data were obtained from Ohio Edison in preprocessed format.

5.1.3 Stack Height Analysis

A Good Engineering Practice (GEP) stack height analysis will be conducted. The purpose of the GEP stack height analysis is to evaluate the potential influence of building wake effects from the existing structures on ground level concentrations. Building dimensions will be input to the ISCST model. The worst-case building dimension inputs will be calculated using guidance in the Industrial Source Complex (ISC) User's Guide and the Bowman Environmental Engineering GEP computer program.

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5.1.4 Receptor Grid

A regularly spaced cartesian grid, with a spacing of 250 to 500 meters, surrounding the facility will be developed. Additional receptors will be located along the plant fenceline.

5.2 Future Ambient Air Quality Work

A plant visit was conducted on January 23, 1990. During this visit, Ohio Edison personnel provided the following items:

- Plot plan showing property and fenceline positions
- Building orientation and dimensions
- Stack dimensions

In addition to the above information, photographs were taken during a tour of the facility, and a survey of the local area provided needed information for future modeling work.

END

DATE
FILMED
01/16/92