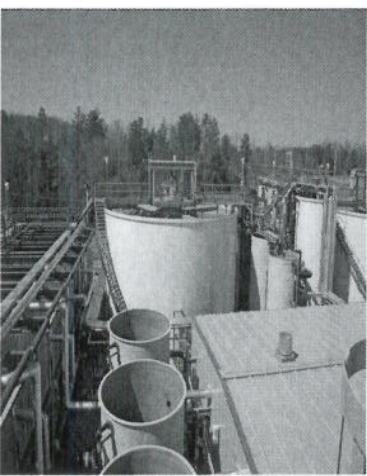
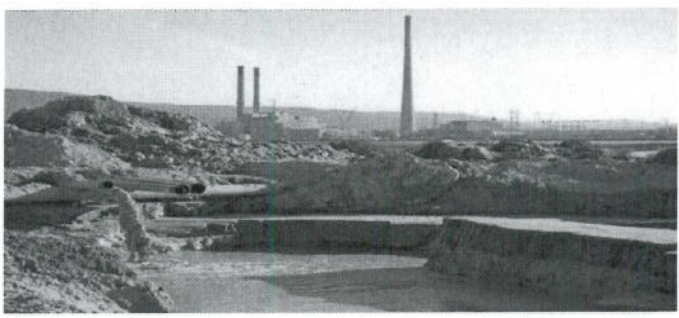
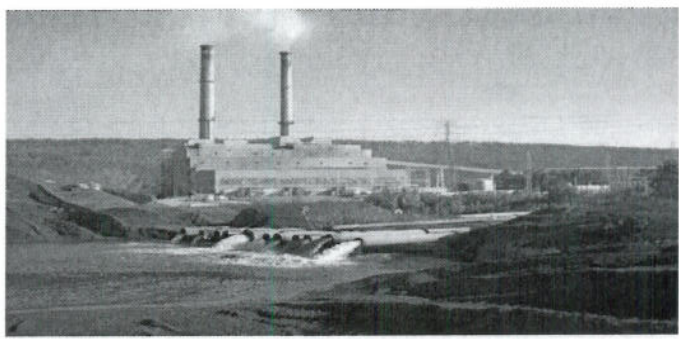




EPA 821-R-09-008

# Steam Electric Power Generating Point Source Category: Final Detailed Study Report



October 2009

This page intentionally left blank.

Final Detailed Study Report  
Final Source Category  
Steam Electric Power Generating



## CONTENTS

	Page
EXECUTIVE SUMMARY.....	xii
1. INTRODUCTION AND BACKGROUND OF THE STUDY .....	1-1
2. DATA COLLECTION ACTIVITIES .....	2-1
2.1 Site Visits.....	2-2
2.2 Wastewater Sampling .....	2-10
2.3 Questionnaire (“Data Request”) .....	2-12
2.4 EPA and State Sources.....	2-15
2.4.1 NPDES Permits and Fact Sheets.....	2-16
2.4.2 State Groups and Permitting Authorities .....	2-16
2.4.3 1974 and 1982 Technical Development Documents for the Steam Electric Power Generating Point Source Category .....	2-16
2.4.4 CWA Section 316(b) - Cooling Water Intake Structures Supporting Documentation and Data.....	2-17
2.4.5 Office of Air and Radiation .....	2-17
2.4.6 Office of Research and Development.....	2-18
2.4.7 Office of Solid Waste and Emergency Response .....	2-18
2.5 Interactions with the Utility Water Act Group .....	2-18
2.5.1 Database of Power Plant Information.....	2-19
2.5.2 Wastewater Sampling .....	2-19
2.5.3 Data Request .....	2-20
2.5.4 NPDES Form 2C.....	2-20
2.6 Interactions with the Electric Power Research Institute (EPRI).....	2-20
2.7 Department of Energy (DOE).....	2-21
2.8 Other Sources.....	2-22
2.8.1 Wastewater Treatment Equipment Vendors .....	2-22
2.8.2 U.S. Geological Survey (USGS) COALQUAL Database .....	2-22
2.8.3 Literature and Internet Searches .....	2-22
2.8.4 Environmental Groups and Other Stakeholders .....	2-22
3. STEAM ELECTRIC INDUSTRY PROFILE.....	3-1
3.1 Overview of the Electric Generating Industry .....	3-1
3.1.1 Demographics of the Electric Generating Industry .....	3-3
3.1.2 Steam Electric Power Generating Industry.....	3-4
3.2 Steam Electric Process and Wastewater Sources.....	3-12
3.2.1 Fly Ash and Bottom Ash.....	3-15
3.2.2 Flue Gas Desulfurization .....	3-16
3.2.3 Selective Catalytic Reduction.....	3-17
3.2.4 Condenser Cooling.....	3-18
3.2.5 Low Volume Wastes.....	3-20
3.2.6 Metal Cleaning.....	3-21
3.2.7 Coal Piles .....	3-21
3.2.8 Landfill Leachate and Runoff.....	3-23



## CONTENTS (Continued)

	Page
3.2.9 Combined Cycle Generating Units .....	3-25
3.2.10 Integrated Gasification Combined Cycle (IGCC).....	3-26
3.2.11 Carbon Capture and Storage .....	3-29
3.3 Effluent Guidelines for the Steam Electric Power Generating Point Source Category .....	3-32
4. FLUE GAS DESULFURIZATION SYSTEMS .....	4-1
4.1 Coal-Fired FGD System Statistics .....	4-1
4.1.1 Current Coal-Fired FGD System Profile .....	4-1
4.1.2 Projected Use of FGD Systems at Coal-Fired Plants.....	4-4
4.2 Process Description and Wastewater Generation .....	4-7
4.2.1 Forced Oxidation FGD Systems .....	4-7
4.2.2 Inhibited Oxidation FGD System .....	4-10
4.2.3 Other Types of FGD Systems .....	4-13
4.3 FGD Wastewater Characteristics .....	4-15
4.4 FGD Wastewater Treatment Technologies.....	4-26
4.4.1 Settling Ponds .....	4-26
4.4.2 Chemical Precipitation.....	4-27
4.4.3 Biological Treatment .....	4-30
4.4.4 Constructed Wetlands .....	4-33
4.4.5 Vapor-Compression Evaporation System.....	4-33
4.4.6 Design/Operating Practices Achieving Zero Discharge .....	4-36
4.4.7 Other Technologies under Investigation .....	4-40
4.4.8 Wastewater Treatment System Use in the Coal-Fired Steam Electric Industry .....	4-43
4.5 Comparison of FGD Wastewater Control Technologies .....	4-50
4.6 FGD Pollutant Loads Estimates.....	4-68
4.6.1 FGD Wastewater Treatment Industry Profile .....	4-68
4.6.2 Calculation of Loads .....	4-69
4.6.3 Industry Baseline and Treatment Technology Loads .....	4-70
5. COAL ASH HANDLING SYSTEMS .....	5-1
5.1 Fly Ash Handling Operations .....	5-1
5.2 Bottom Ash Handling Operations.....	5-3
5.3 Ash Transport Water Characteristics .....	5-5
5.4 Ash Transport Water Treatment Systems .....	5-11
6. ENVIRONMENTAL ASSESSMENT OF COAL COMBUSTION WASTEWATER .....	6-1
6.1 Coal Combustion Wastewater Pollutants.....	6-2
6.2 Coal Combustion Wastewater Interactions with the Environment.....	6-7
6.2.1 Discharges to Surface Waters .....	6-8
6.2.2 Leaching to Groundwater .....	6-11
6.2.3 Surface Impoundments and Constructed Treatment Wetlands as Attractive Nuisances .....	6-13

**CONTENTS (Continued)**

	<b>Page</b>
6.3	Types of Environmental Effects ..... 6-13
6.3.1	Lethal Effects ..... 6-14
6.3.2	Sublethal Effects ..... 6-15
6.3.3	Population and Community Effects ..... 6-16
6.3.4	Human Health Impacts ..... 6-17
7.	PRELIMINARY INVESTIGATION OF OTHER INDUSTRY SEGMENTS ..... 7-1
7.1	Alternative-Fueled Steam Electric Plants ..... 7-2
7.1.1	Demographic Data for Alternative-fueled Steam Electric Plants ..... 7-3
7.1.2	Alternative-Fueled Steam Electric Fuel Types and Processes ..... 7-3
7.1.3	Summary of NPDES Permit Review ..... 7-9
7.2	Industrial Non-Utilities ..... 7-10
7.2.1	Overview of Industrial Non-Utilities ..... 7-11
7.2.2	Demographic Data for Fossil-Fueled Industrial Non-Utilities ..... 7-12
7.2.3	Review of Industrial Non-Utility Discharge Permits ..... 7-18
7.2.4	Contacts with Industrial Non-Utilities ..... 7-20
7.3	Steam and Air Conditioning Supply Plants ..... 7-21
7.3.1	Wastewater Discharge Characterization Data ..... 7-23
7.3.2	NPDES Permit Review ..... 7-23
7.3.3	Contacts with Steam Supply Companies ..... 7-26
7.4	Combination Utility Plants ..... 7-27
7.4.1	Wastewater Discharge Characterization Data ..... 7-28
7.4.2	NPDES Permit Review ..... 7-31
8.	REFERENCES ..... 8-1



---

**LIST OF TABLES**

	<b>Page</b>
2-1 Summary of the Detailed Study Site Visits .....	2-5
2-2 Summary of the Detailed Study Sampling Program.....	2-10
2-3 Analytes Included in the Detailed Study Sampling Program .....	2-11
2-4 Profile of Coal-Fired Power Plants Operated by Data Request Respondents .....	2-13
3-1 Distribution of U.S. Electric Generating Plants by NAICS Code in 2002 .....	3-4
3-2 Distribution of Prime Mover Types for Plants Regulated by the Steam Electric Power Generating Effluent Guidelines .....	3-7
3-3 Distribution of Fuel Types Used by Steam Electric Generating Units.....	3-8
3-4 Types of Fuel Used by Stand-Alone and Combined Cycle Steam Turbines.....	3-10
3-5 Distribution of Fuel Types for Combined Cycle Units Regulated by the Steam Electric Power Generating Effluent Guidelines.....	3-11
3-6 Distribution by Size of Steam Electric Capacity, Plants, and Electric Generating Units Regulated by the Steam Electric Effluent Guidelines.....	3-12
3-7 Coal Pile Runoff Generation Reported for the EPA Data Request .....	3-22
3-8 Current Effluent Guidelines and Standards for the Steam Electric Power Generating Point Source Category.....	3-33
4-1 Scrubbed Coal-Fired Steam Electric Power Generation as of June 2008.....	4-2
4-2 Characteristics of Coal-Fired Power Plants with Wet FGD Systems .....	4-3
4-3 Projected Future Use of FGD Systems at Coal-Fired Power Plants.....	4-5
4-4 FGD Scrubber Purge Flow Rates.....	4-16
4-5 Influent to FGD Wastewater Treatment System Concentrations .....	4-19
4-6 FGD Scrubber Purge Self-Monitoring Data .....	4-25
4-7 FGD Wastewater Treatment Systems Identified During EPA's Detailed Study.....	4-44
4-8 Pollutant Concentrations in Sampled Effluent from FGD Wastewater Treatment Systems .....	4-57
4-9 Monitoring Data: Pollutant Concentrations in Effluent from Settling Ponds.....	4-64