**TREATMENT OF METAL-LADEN HAZARDOUS WASTES
WITH
ADVANCED CLEAN COAL TECHNOLOGY BY-PRODUCTS**

QUARTERLY TECHNICAL PROGRESS REPORT

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SEPTEMBER 30 - DECEMBER 30, 1997

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April 28, 1999

Award No. DE-FC21-94MC31175

**For: U. S. Department of Energy
Federal Energy Technology Center
Morgantown, West Virginia**

This Quarterly Technical Progress Report was prepared with the support of the U.S. Department of Energy, under Cooperative Agreement No. DE-FC21-94MC31175. However, any opinions, findings, conclusions, or recommendations expressed herein are those of the authors and do not necessarily reflect the views of the DOE.

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EXECUTIVE SUMMARY

During the ninth quarter of Phase 2, work continued on conducting scholarly work, preparing for field work, preparing and delivering presentations, and making additional outside contacts.

Scholarly Work

The graduate student assigned to this project from the Department of Civil and Environmental Engineering has continued her work on evaluation of the long-term stability of Phase I samples. A preliminary report of her work has been prepared. After two years, the leachability of lead decreased or remained nearly constant in both the TCLP and ASTM leaching tests. In contrast, while the leachability of zinc in the TCLP leaching test also decreased or remained nearly constant, its leachability in the ASTM leaching test increased.

Preparation for Field Work

An addition was made to the senior staff of MAX Environmental Technologies, Inc.

Reports and Presentations

One presentation was made at a major technical meeting on ash utilization.

Outside Contacts

Members of the project team attended two events organized by U.S.DOE/FETC, related to utilization of coal combustion by-products.

Three activities focused upon ash utilization in India:

- a letter detailing ash utilization research at Pitt was sent to IIT Delhi
- discussions were held at FETC on the U.S.AID/U.S.DOE Interagency Program with India
- A proposal was coordinated for research and engineering on ash utilization in India.

The project team learned of a manufacturer in the Pittsburgh region that is making brick and block from fly ash.

Plans for the Next Quarter

During the quarter from December 30, 1997 through March 30, 1998, work will continue on Tasks 4 and 5 of Phase 1. The graduate student assigned to this project will continue her scholarly work during this quarter.

Work on Task 1 of Phase 2 will continue. The principal investigator will maintain contact with MAX Environmental Technologies, Inc., as it plans the installation of equipment at the Mill Service Yukon Plant to conduct Phase 2 of the project.

INTRODUCTION

This thirteenth quarterly report describes work done during the thirteenth three-month period of the University of Pittsburgh's project on the "Treatment of Metal-Laden Hazardous Wastes with Advanced Clean Coal Technology By-Products."

This report describes the activities of the project team during the reporting period. The principal work has focussed upon new laboratory evaluation of samples from Phase 1, discussions with MAX Environmental Technologies, Inc., on the field work of Phase 2, preparing and giving presentations, and making and responding to a number of outside contacts.

LABORATORY AND FIELD WORK

Scholarly Activity

Jana Agostini, the graduate student in the Civil and Environmental Engineering Department, continued her work in the environmental laboratories on the ninth floor of Benedum Engineering Hall. She is evaluating the leachability of aged samples prepared during Phase I. Preliminary results of her work are presented in Appendix A. A comprehensive report of her project will be provided in a formal document at a later time.

Preparation for Field Work

In mid-November Hank Springer, Facilities Engineer for the Mill Service Yukon Plant of MAX Environmental Technologies, Inc. (MAX), reported that MAX has just hired a new Vice President of Sales, which adds considerably to its management capability. He anticipates that the application for a low-interest loan to fund the installation of the equipment needed to carry out this project to utilize dusty by-products to treat metal-laden hazardous waste at the Yukon Plant will be completed in the next quarter.

REPORTS AND PRESENTATIONS

On October 21 the paper entitled "Laboratory Evaluation and Commercial Demonstration of Hazardous Waste Treatment Using Clean Coal Technology By-Products," was presented at the 1997 International Ash Utilization Symposium in Lexington, Kentucky. The paper published in the proceedings was reproduced in the appendix of the previous quarterly report.

OUTSIDE CONTACTS

MAX Environmental Technologies, Inc.

From time-to-time, in addition to work on the project, which is the subject of this report, MAX and Pitt discuss other collaborative opportunities. One such was introduced in the previous quarterly report. MAX is exploring the possibility of backfilling several mine openings that are under its Bulger Plant just west of Pittsburgh. MAX is in the process of closing the Bulger Plant and wishes to stop the old underground mine openings while doing so.

MAX and Pitt are exploring the possibility of a backfill demonstration in cooperation with FETC at the Bulger Plant. To learn more about the FETC program, Mr. Springer attended the site tour of the Roberts-Dawson Mine Injection Project on October 29, and the principal and co-principal investigators of this project, Dr. Cobb and Prof. Neufeld, attended the informal meeting on the topic of coal combustion by-product utilization in environmental remediation projects in western Pennsylvania, held on December 4 at the Westmoreland Conservation District Office in Donohoe Center, Greensburg, Pennsylvania.

Indian Institute of Technology, Delhi

On November 11 the principal investigator sent a letter to Prof. V. S. Raju, Director of the Indian Institute of Technology, Delhi, further describing the activities of the School of Engineering on the utilization of coal combustion by-products. A copy of this correspondence is provided in Appendix B.

GAI Consultants, Inc.

Dr. Shiv K. Dube, the Research Associate in the Department of Chemical and Petroleum Engineering, completed his work with GAI Consultants, Inc. (GAI) on its project to develop demonstration projects in India, focusing on beneficial use of coal combustion by-products. Dr. Dube returned to India on November 30.

Advanced Technology Systems, Inc.

During November the co-principal investigator of this project assisted in the development of a proposal from Advanced Technology Systems, Inc. for a two-year project under which several graduate students, one being from India, would conduct applied research in the utilization of coal combustion by-products. The specific research areas would be defined in consultation with FETC, GAI Consultants, Inc., and the National Thermal Power Corporation of India. They would be expected to be useful for implementation in a prototype project in India at the end of the two-year period. The proposal was shared with Dr. Dube and taken with him back to India for further consideration there.

U.S.AID/U.S.DOE Interagency program with India

On November 14 the principal and co-principal investigators met with Gary Staats at FETC to discuss the U.S.AID/U.S.DOE Interagency Program with India and the potential for the educational and research activities of the University of Pittsburgh to be drawn into it. Mr. Staats described the elements of the interagency program:

- examination of energy-related environmental challenges in India
- identification of appropriate technology transfer
- training in the U.S. through the Institute for International Education
- training in India through the National Thermal Power Corporation

The exchange of letters of interest between Pitt and IIT Delhi was noted as a good step toward establishing a firm connection between the two schools to facilitate any project that develops for Pitt in the interagency program.

Two possible early opportunities for focussed travel to India for Pitt faculty were mentioned — a Pennsylvania trade mission, led by the Governor, and a fly ash utilization conference in mid-January 1998.

It was suggested that, as discussions with FETC develop, contacts at U.S.AID, IIE and the Pennsylvania Governor's Office might prove useful. Travel support might be sought through a Fulbright grant or from a utility with ties to India.

Pittsburgh Minerals and Environmental Technologies

Applied Recycling of Lexington, Massachusetts has recently purchased Pittsburgh Minerals and Environmental Technologies (PMET) of New Brighton, Pennsylvania. PMET makes brick from fly ash. Applied Recycling has developed a new process for making brick and block out of bottom and fly ash. Mr. Jack Edward, president of Applied Research, suggested that the Pitt ash utilization team contact Mr. William F. Sutton, the president of PMET, to discuss mutual interests.

ADMINISTRATIVE ASPECTS

This section provides the monthly highlights, and closes by comparing progress with the milestone chart.

Monthly Highlights

Here are the highlights of the ninth three month period of the second phase of the project.

September 30 - October 30, 1997

- Paper is presented at the 1997 International Ash Utilization Symposium in Lexington, Kentucky.
- Facilities engineer of the Mill Service Yukon Plant attends the site tour of the Roberts-Dawson Mine Injection Project.

October 30 - November 30, 1997

- Proposal is prepared by Advanced Technology Systems, Inc., for ash utilization work in India.
- Discussions are held at FETC on possible University role in U.S.AID/U.S.DOE Interagency Program with India.
- Letter is sent to IIT Delhi describing ash utilization work at Pitt.
- Dr. Shiv K. Dube leaves Pittsburgh to return to India.

November 30 - December 30, 1997

- Jana Agostini prepares an interim report on her laboratory evaluations.
- Principal and co-principal investigator attend the informal meeting on coal combustion by-product utilization in environmental remediation projects in Western Pennsylvania.

Comparison of Progress with Milestone Chart

The following task for Phase 2 had been scheduled for completion during the first quarter of Phase 2:

- Task 1 - Test Plan for Phase 2

Task 1 still was not completed during the ninth period of this phase. The decision in early April 1996 by METC that an environmental assessment of the Phase 2 project at the Yukon plant of Mill Service, Inc., would have to be conducted and the subsequent withdrawal in late April 1996 by MSI from Phase 2 necessitated a search for a new subcontractor to host and participate in the commercial test of Phase 2. MAX Environmental Technologies, Inc., has rejoined the project team and is planning modifications at the Mill Service Yukon Plant (MSYP) to enable it to enter this business area and carry out the field work on this project. The test plan for Phase 2 will be prepared when the equipment is ready at MSYP for carrying out the demonstration.

Work continued on two tasks from Phase 1:

- Task 4 - Treatment of Metal-Laden Waste with CCT Solid By-Product
- Task 5 - Data Analysis

Work on Tasks 4 and 5 of Phase 1 will continue into the tenth quarter of Phase 2. The fourth by-product and the final three residues are no longer being actively sought. When the Phase 2 testing program is initiated, consideration will be given to reestablishing this activity.

PLAN FOR THE NEXT QUARTER

During the quarter from December 30, 1997 through March 30, 1998, work will continue on Tasks 4 and 5 of Phase 1. The graduate student assigned to this project will continue her scholarly work during this quarter.

Work on Task 1 of Phase 2 will continue. The principal investigator will maintain contact with MAX Environmental Technologies, Inc., as it plans the installation of equipment at the Mill Service Yukon Plant to conduct Phase 2 of the project.

APPENDIX A

AGING STUDIES ON SAMPLES USING CLEAN COAL TECHNOLOGY (CCT) BY-PRODUCTS AS STABILIZATION/SOLIDIFICATION (S/S) REAGENTS

**Aging Studies on Samples Using Clean Coal Technology (CCT) By-
Products as Stabilization/Solidification (S/S) Reagents**

**"Treatment of Metal-Laden Wastes with Advanced Clean Coal Technology By-
Products"**

**University of Pittsburgh
Pittsburgh, Pennsylvania
Jana Agostini, BS Chemical Engineering**

Studies at the University of Pittsburgh are examining the effects of age on the durability of the waste form. Leaching tests have been completed on samples up to two years old which were initially prepared by mixing hazardous metal-laden wastes with Clean Coal Technology (CCT) by-products. The samples were originally subjected to an EPA leaching test, namely, the Toxicity Characteristic Leaching Procedure (TCLP), which uses an acetic acid extraction fluid; and the ASTM D 3987 leaching test which uses deionized water as the extraction fluid. These two tests were rerun after a period of one or two years to determine if a change in the leachability of metals occurs. Since lead and zinc were the metals of most concern in the waste samples, the aging studies have focused on these metals.

Several graphs are attached to this report which show the TCLP test results for lead and zinc on the CCT stabilized samples as a function of time. In addition, the ASTM test results for these two metals are also included. The data has been compiled into tables which are also attached.

The results of the TCLP tests showed that for most treated waste mixtures, the leachability of lead and zinc decreased or remained nearly constant after two years. Though microstructural analysis has not yet been performed on these samples, one obvious parameter to check, in explaining these results, is the pH of the leachate. Table 1, below, compares the leachate pH with the lead concentration for several of the samples.

Table 1 - Comparison of Leachate pH with Lead Concentration in CCT Stabilized Samples

Sample Identification	Initial		Two Year	
	Leachate pH	Lead (mg/L)	Leachate pH	Lead (mg/L)
Munitions Soil w/ 50% Consol By-product	4.54	<0.01	6.19	2.17
Munitions Soil w/ 50% Tidd By-product	7.08	1.20	5.85	1.25
Munitions Soil w/ 100% Ebensburg By-product	n/a	5.60	4.90	5.59
WWTP Soil w/ 50% Tidd By-product	6.36	2.30	5.93	0.75
WWTP Soil w/ 50% Ebensburg By-product	8.06	0.31	6.09	0.33
Industrial Soil w/ 50% Tidd By-Product	7.08	1.70	6.16	5.87

The results of the ASTM leaching test for lead indicate that the lead concentration in the leachate has decreased with time. In contrast, the zinc concentration in the ASTM leachate has increased with time. These results indicate that the lead and zinc in the stabilized waste forms are not bound within the matrix the same way. Further analysis of these samples will be completed to determine the manner in which lead and zinc have been incorporated into the stabilized waste form.

TCLP Test

Lead Analysis

TCLP Lead Concentration (mg/L)

15
10
5
0

Current BDAT
Standard

1

90

730

Time (days)

Munitions Soil w/ 100% EPC

WWTP Soil w/ 50% EPC

WWTP Soil w/ 50% Tidd

Munitions Soil w/ 50% Tidd

Munitions Soil w/ 50% Consol

Industrial Soil w/ 50% Tidd

ASTM Test

Lead Analysis

ASTM Lead Concentration (mg/L)

Munitions Soil w/ 100% EPC

Munitions Soil w/ 50% Tidd

WWTP Soil w/ 50% EPC

Munitions Soil w/ 50% Consol

WWTP Soil w/ 50% Tidd

Industrial Soil w/ 50% Tidd

Time (days)

TCLP Test

Zinc Analysis

ASTM Test

Zinc Analysis

ASTM Zinc Concentration (mg/L)

Munitions Soil w/ 100% EPC

WWTP Soil w/ 50% EPC

WWTP Soil w/ 50% Tidd

Munitions Soil w/ 50% Tidd

Munitions Soil w/ 50% Consol

Industrial Soil w/ 50% Tidd

TCLP Data - Cylinders
Lead (mg/L)

Time	BDAT Standard		Battery Sludge	Sandblast Waste	Sandblast Waste	Munitions Soil	WWTP Soil	WWTP Soil	Munitions Soil	Munitions Soil	Industrial Soil
(days)	Current	Future	w/ 72.2% Tidd	w/ 30% Consol	w/ 50% Tidd	w/ 100% EPC	w/ 50% EPC	w/ 50% Tidd	w/ 50% Tidd	w/ 50% Consol	w/ 50% Tidd
mediate	5.0	0.37				5.60	0.31	2.30	1.20	<0.01	1.70
1	5.0	0.37		0.48	26.88	4.30	0.18	2.10	0.34	0.28	1.60
3	5.0	0.37		0.33	25.80						
7	5.0	0.37		0.37	29.80						
14	5.0	0.37		0.52	31.28						
28	5.0	0.37		0.24	67.80						
90	5.0	0.37	0.68			9.03	5.96	0.56	1.21	0.87	14
365	5.0	0.37		1.07	35						
730	5.0	0.37	0.42			5.59	0.33	0.75	1.25	2.17	5.87

ASTM Data - Cylinders
Lead (mg/L)

Time	Battery Sludge	Sandblast Waste	Sandblast Waste	Munitions Soil	WWTP Soil	WWTP Soil	Munitions Soil	Munitions Soil	Industrial Soil
(days)	w/ 72.2% Tidd	w/ 30% Consol	w/ 50% Tidd	w/ 100% EPC	w/ 50% EPC	w/ 50% Tidd	w/ 50% Tidd	w/ 50% Consol	w/ 50% Tidd
1	1.30	75.30	4.80	0.56	0.94	0.34	0.15	0.29	0.51
365		3.86	1.05						
730	0.05			0.09	0	0.1	0	0.12	0.37

TCLP Data - Cylinders
Zinc (mg/L)

Time	BDAT Standard	Battery Sludge	Sandblast Waste	Sandblast Waste	Munitions Soil	WWTP Soil	WWTP Soil	Munitions Soil	Munitions Soil	Industrial Soil
(days)	Current	Future	w/ 72.2% Tidd	w/ 30% Consol	w/ 50% Tidd	w/ 100% EPC	w/ 50% EPC	w/ 50% Tidd	w/ 50% Tidd	w/ 50% Tidd
Immediate	---	---	1.40	1.40	<1	1.80	<1	1.00	1.00	<0.01
1	---	---	1.40	1.40	<1	1.80	<1	1.00	1.00	2.4
90	---	---	0.20	1.3	0.26	0.32	0.08	0.23	0.39	1.10
365	---	---	5.3	1.95		3.59	0.27	0.21	0.09	
730	---	---	5.3							1.09

ASTM Data - Cylinders
Zinc (mg/L)

Time	Battery Sludge	Sandblast Waste	Sandblast Waste	Munitions Soil	WWTP Soil	WWTP Soil	Munitions Soil	Munitions Soil	Industrial Soil
(days)	w/ 72.2% Tidd	w/ 30% Consol	w/ 50% Tidd	w/ 100% EPC	w/ 50% EPC	w/ 50% Tidd	w/ 50% Tidd	w/ 50% Tidd	w/ 50% Tidd
1	0.08	0.05	<0.05	0.07	0.03	0.02	0.04	0.10	0.04
365		0.272	0.277						
730	0.214			0.203	0.205	0.247	0.197	0.156	0.209

**TCLP Data - Cylinders
Cadmium (mg/L)**

Time (days)	BDAT Standard		Battery Sludge	Sandblast Waste	Sandblast Waste	Munitions Soil	WWTP Soil	WWTP Soil	Munitions Soil	Munitions Soil	Industrial Soil
	Current	Future	w/ 72.2% Tidd	w/ 30% Consol	w/ 50% Tidd	w/ 100% EPC	w/ 50% EPC	w/ 50% Tidd	w/ 50% Tidd	w/ 50% Consol	w/ 50% Tidd
mediate	1.0	0.19		<0.01	<0.01	<0.1	<0.01	<0.01	<0.01	<0.01	<0.10
1	1.0	0.19		<0.01	<0.01	<0.1	<0.01	<0.01	<0.01	0.28	<0.10
90	1.0	0.19	0.00			0.02	0.01	0.01	0.01	0.02	<0.05
365	1.0	0.19		0.03	0.03						
730	1.0	0.19	0.03			0.05	0.02	0.03	0.04	0.03	0.03

**ASTM Data - Cylinders
Cadmium (mg/L)**

Time (days)	Battery Sludge		Sandblast Waste		Sandblast Waste		Munitions Soil		WWTP Soil		WWTP Soil		Munitions Soil		Munitions Soil		Industrial Soil	
	w/ 72.2% Tidd	w/ 30% Consol	w/ 50% Tidd	w/ 100% EPC	w/ 50% EPC	w/ 50% Tidd	w/ 100% EPC	w/ 50% EPC	w/ 50% Tidd	w/ 50% Tidd	w/ 50% Tidd	w/ 50% Tidd	w/ 50% Tidd	w/ 50% Tidd	w/ 50% Tidd	w/ 50% Tidd	w/ 50% Tidd	w/ 50% Tidd
1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
365		0.004	0.007															
730	0.01			0.005	0.005	0.008	0.005	0.005	0.008	0.004	0.008	0.004	0.008	0.008	0.009	0.009	0.009	0.009

TCLP Data - Cylinders
Chromium (mg/L)

Time (days)	BDAT Standard		Battery Sludge	Sandblast Waste	Sandblast Waste	Munitions Soil	WWTP Soil	WWTP Soil	Munitions Soil	Munitions Soil	Industrial Soil
	Current	Future	w/ 72.2% Tidd	w/ 30% Consol	w/ 50% Tidd	w/ 100% EPC	w/ 50% EPC	w/ 50% Tidd	w/ 50% Tidd	w/ 50% Consol	w/ 50% Tidd
immediate	5.0	0.86		<0.1	<0.1	<0.1	<0.1	0.17	<0.1	<0.1	<0.10
1	5.0	0.86		0.14	<0.1	<0.1	<0.1	0.16	<0.1	<0.1	<0.10
90	5.0	0.86	0.06			0.18	0.18	0.02	0.05	0.24	<0.05
365	5.0	0.86		0.02	0.02						
730	5.0	0.86	0.01			0.27	0.03	0.04	0.04	0.02	0.01

ASTM Data - Cylinders
Chromium (mg/L)

Time (days)	Battery Sludge	Sandblast Waste	Sandblast Waste	Munitions Soil	WWTP Soil	WWTP Soil	Munitions Soil	Munitions Soil	Industrial Soil
	w/ 72.2% Tidd	w/ 30% Consol	w/ 50% Tidd	w/ 100% EPC	w/ 50% EPC	w/ 50% Tidd	w/ 50% Tidd	w/ 50% Consol	w/ 50% Tidd
1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
365		0.034	0						
730	0.025			0.010	0.020	0.065	0.013	0.035	0.010

APPENDIX B

**LETTER FROM UNIVERSITY OF PITTSBURGH TO
IIT DELHI, NOVEMBER 11, 1997**

University of Pittsburgh

SCHOOL OF ENGINEERING
Chemical and Petroleum Engineering Department

November 11, 1997

Professor V. S. Raju, Director
Indian Institute of Technology Delhi
Hauz Khas, New Delhi — 110 016

Dear Professor Raju:

Dean Gerald D. Holder has shared with me your kind letter of July 7, 1997 in which you requested more information about the work we are doing here at the University of Pittsburgh.

During the past five months, we have been working closely with Dr. Shiv Dube, who is on leave from the National Thermal Power Corporation Ltd to be a Research Associate of ours through the end of November. His principal activity here has been to assist GAI Consultants, Inc., to complete their feasibility study of three demonstration projects at NTPC's National Capital Power Project at Dadri. He also has been paying many visits and giving many presentations to various organizations during this period. We have been discussing details of maintaining a close working relationship with him upon his return to India in several weeks.

As Dean Holder mentioned in his letter of June 23, 1997, the faculty of the School of Engineering are conducting numerous projects relating to the utilization of coal combustion by-products. Much of this work is being directed by Professor Neufeld and myself, and it is this work upon which I shall focus upon in this review.

First, I have provided a brief, one-page vita for both Professor Neufeld and myself. Then I have included ten recent papers that we have coauthored with students and other faculty members:

1. "High-Strength Portland Cement Concrete Containing Municipal Solid Waste Incinerator Ash," James T. Cobb, Jr., C. P. Mangelsdorf, Jean R. Blachere, Kunal Banerjee, Daniel Reed, Clayton Crouch, Coby Miller, Jingqi Li, and Jeanette Trauth, in *Clean Energy from Waste & Coal*, ACS Symposium Series 515, 1992, pages 264-275.
2. "Submerged Upflow Biotower Operation and Computer Simulation," Ronald D. Neufeld, Christopher A. Badali, Dennis Powers and Christopher Carson, *Water Science and Technology*, Vol. 30, No. 11, 1994, pages 143-146.

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3. "Mathematical Analysis of a Municipal Solid Waste Rotary Incinerator," James T. Cobb, Jr., and Kunal Banerjee, in *Conversion and Utilization of Waste Materials*, Taylor and Francis, 1996, pages 221-231.
4. "Characterization of Concretes Formulated with Blends of Portland Cement and Oil Shale Combustion Ash," James T. Cobb, Jr., and C. P. Mangelsdorf, in *Conversion and Utilization of Waste Materials*, Taylor and Francis, 1996, pages 253-262.
5. "Hazardous Waste Stabilization with Clean-Coal Technology Ash Residuals," Ronald D. Neufeld, James T. Cobb, J. Pritts, V. Clifford, C. Bender and J. Beeghly," *Water Science and Technology*, Vol. 34, No. 10, 1996, pages 179-185.
6. "Preparation of a Commercial Test of the Treatment of Metal-Laden Hazardous Wastes with Clean Coal Technology By-Products," James T. Cobb, Jr., Ronald D. Neufeld, Carl F. Bender, Jesse W. Pritts and B. Vourneen Clifford, in *Hazardous and Industrial Wastes*, Proceedings of the Twenty-Ninth Mid-Atlantic Industrial and Hazardous Waste Conference, July 13-16, 1997, Roanoke, Virginia, pages 139-148.
7. "Laboratory Evaluation and Commercial Demonstration of Hazardous Waste Treatment Using Clean Coal technology By-Products," James T. Cobb, Jr., B. Vourneen Clifford, Ronald D. Neufeld, Jesse W. Pritts, Joel H. Beeghly and Carl F. Bender, Proceedings of the 1997 International Ash Utilization Symposium, October 20-22, 1997, Lexington, Kentucky, pages 286-296.
8. "Response of MICROTOX Organisms to Leachates of Autoclaved Cellular Concrete," M. C. Latona, R. D. Neufeld, W. Hu, C. Kelly, and L. E. Vallejo, *Journal of Energy Engineering*, Vol. 123, No. 2, 1997, pages 35-43.
9. "Strength Properties of Autoclaved Cellular Concrete with High Volume Fly Ash," Wenyi Hu, Ronald D. Neufeld, Luis E. Vallejo, Christopher Kelly, and Martin Latona, *Journal of Energy Engineering*, Vol. 123, No. 2, 1997, pages 44-54.
10. "Leachate and Radon Production from Fly Ash Autoclaved Cellular Concrete," M. C. Latona, R. D. Neufeld, L. E. Vallejo, D. Brandon, W. Hu, and C. Kelly, *Journal of Energy Engineering*, Vol. 123, No. 2, 1997, pages 55-67.

Professor Neufeld and I will begin making contacts with the Federal Energy Technology Center of the U.S. Department of Energy later this week to explore with them how a joint program of education and research can be developed between the University of Pittsburgh and IIT Delhi. Dr. Dube has also asked that one of us be included in the activities of the International Conference on

Professor V. S. Raju
November 11, 1997
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Fly Ash Disposal & Utilization in New Delhi on January 20-22, 1998. In our exploration we will be seeking the funds for at least one of us to travel to New Delhi soon to confer with you and with NTPC about our developing relationships.

Professor Neufeld and I would welcome more information from you about the work you are doing on the subject.

Finally, we would certainly welcome an opportunity to meet with you in Pittsburgh, should your travels bring you to the United States and to our city, and show you the facilities here for work on ash utilization.

Our best regards,

Sincerely,

James T. Cobb, Jr., P.E.
Associate Professor

Enclosures

cc. (without enclosures)

Prof. Ronald Neufeld
Prof. Alan Russell
Prof. Rafael Quimpo
Dr. Shiv Dube