

**Anthracite R&D Needs
CRADA 89-001, Final Report**

September 1990

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ANTHRACITE R&D NEEDS

1.0 OBJECTIVE AND TASKS

This subtask had the specific objective of developing a plan of action designed to define new research and development initiatives for anthracite coal that will yield near- and mid-term results

It was anticipated that the following activities would be performed:

- Activity 1 - R&D Needs for Commercial Boilers

A detailed plan would be developed for implementing an R&D program for the development of high performance anthracite-fired boiler systems suitable for meeting space heating and hot water requirements of large buildings. Developing this plan would require assistance by PEDA and US DOE/PETC personnel in reviewing the requirements for the plan and a timetable for its completion.

- Activity 2 - R&D Opportunities

Additional analyses would be conducted of R&D opportunities required to further extend the work completed under Task Authorization E-3. It was anticipated that these further analyses of R&D opportunities would address R&D needs for anthracite in the general areas of anthracite beneficiation and/or utilization and include market, technical, and economic aspects of deeply cleaned anthracite.

During the course of this work, guidance provided by PETC and PEDA indicated that all work was to be confined to Activity 1 above.

2.0 BACKGROUND AND PROBLEM STATEMENT

Boilers with a firing rate between 2 and 20 million Btus per hour represent an attractive market opportunity for Pennsylvania anthracite. This market primarily consists of boilers used for heating buildings and meeting building hot water requirements. In addition, there are combined heating/low pressure process steam applications in the industrial sector. A review of existing anthracite-fired commercial boiler systems has revealed dated technology that seriously impedes the ability of Pennsylvania anthracite to compete favorably with fuel oil or natural gas. Moreover, uncertainties regarding the future course of oil and natural gas prices have inhibited private sector investments directed at developing and marketing anthracite-fired boiler systems that offer the performance, reliability, and most importantly, the convenience of operation being demanded by commercial and small industrial users.

3.0 R&D PLAN SCOPE

The purpose of this R&D plan is to foster the development of one or more high-performance, anthracite-fired boiler systems suitable for meeting space heating and hot water requirements of large buildings. The R&D plan is specifically targeted at boiler systems with a firing rate of two to four million Btus per hour. This limited size range offers the opportunity for cost-effective development and testing work that can eventually be applied to a broader range of boiler sizes. As defined herein, a boiler system includes the following:

- Fuel Handling: Off-loading equipment for anthracite delivery trucks; on-site fuel receiving and storage; and fuel transfer from on-site storage to the boiler;
- Combustion and Heat Transfer: Fuel ignition and combustion; heat transfer for hot water and/or low pressure steam production; combustor/boiler fabrication materials
- Ash Handling: Ash removal from the boiler and transfer to storage; on-site ash storage; ash removal from site; and
- Control Systems: All associated control systems, including controls required for load variation, start-up, shut-down, system safety, and environmental performance.

It is recommended that financial assistance be provided for a three phase development program. The overall program goal is to develop and demonstrate anthracite boiler systems that can effectively compete with their oil and gas-firing counterparts.

Phase I consists of a design competition for boiler systems with a firing rate of between two and four million Btus per hour. The design objectives consist of: (1) reducing total system purchase and installation costs, (2) significantly enhancing the convenience and reliability of using anthracite, and (3) assuring complete compatibility with user requirements. The duration of Phase I will be seven months, and it is anticipated that approximately three competing contractors will be selected, with a \$35,000 ceiling on the Pennsylvania Energy Office (PEO) support for the Phase I work of each contractor. Major criteria for contractor selection are the contractor's qualifications to bring to bear state-of-the-art approaches to solids handling, combustion, heat transfer, and automated control systems; to conduct the R&D and demonstration activities of subsequent phases, and to manufacture and market a successfully developed anthracite boiler system. Recognizing the breadth of the overall program, the Pennsylvania Energy Office should encourage responses from contractor teams, including collaborative efforts between Pennsylvania industries and universities. The final product of Phase I is an engineering design, including costs of the proposed boiler system, and a detailed cost plan for proposed Phase II activities.

Teams with the most promising designs will be selected by the Pennsylvania Energy Office for the second phase of the program. The number of teams selected will be based upon the quality of the Phase I design and the amount of funding available to the Pennsylvania Energy Office for supporting Phase II and Phase III activities. Phase II will consist of laboratory R&D and bench-scale testing of components, the selection of a site for Phase III system demonstration and evaluation, an up-dated, site-specific engineering design, and a detailed cost plan for proposed Phase III activities. In the component development portion of Phase II, each team will be given the flexibility to work on its primary design approach, as well as on lower risk or high risk/high pay-off variations. The Phase II objective is to obtain the component performance information required to design, assemble, and operate an integrated system. At the conclusion of Phase II, the Pennsylvania Energy Office will evaluate each team's work and authorize one or more teams to proceed to Phase III.

Each team selected for Phase III will assemble an integrated boiler system at a site where long-term operations are possible and where equipment performance can be closely monitored. To keep costs within bounds, the selected site should be capable of using the steam or hot water produced by the demonstration. Recognizing that the demonstration will represent first-of-a-kind technology, provision should be made for equipment modifications required to resolve potential problems that may be encountered during start-up and initial operations. The specific objective of Phase III is to develop and document system design and performance at a level adequate to support a decision to commercialize the system.

4.0 EVALUATION AND SELECTION RECOMMENDATIONS

4.1 Introduction

It is recommended that all proposals received be reviewed and evaluated by a committee of personnel selected by the Pennsylvania Energy Office. This committee will recommend for selection those proposals that are determined to provide superior overall responses to the RFP. In determining superior overall responses, predominant consideration will be given to the technical content of the proposal (Part I), provided that the Budget Proposal (Part II) conforms to the requirements of the RFP, cost estimates are realistic, and the requested support from the Pennsylvania Energy Office for the Phase I Design Competition does not exceed \$35,000.00.

4.2 Technical Evaluation Criteria

It is recommended that technical proposals will be evaluated on a point basis according to the following evaluation criteria and weightings.

4.2.1 Understanding of the Problem

The proposal should demonstrate that the proposer has a clear understanding of the goals of the RFP, including boiler system performance requirements, and system concepts and state-of-the-art technologies that can be applied to develop a high-performance anthracite boiler system that can significantly improve the competitive posture of anthracite as a fuel for commercial sector applications.

4.2.2 Organizational Qualifications

The proposal should demonstrate that the proposing organization (or team of organizations) has the ability to conduct all the tasks in Phases I through III of the Statement of Work (Attachment A) and to manufacture and market a successfully developed anthracite boiler system. This would include the quality and relevancy of recently completed activities in the areas of boiler system design; R&D and component development; prototype system installation, operation and evaluation; and manufacturing and marketing. This criterion would also include consideration of existing facilities and equipment that the proposing organization has available for the performance of the project, with emphasis on R&D and testing facilities that may be required for Phase II Component Development.

4.2.3 Personnel Qualifications and Experience

The proposal should demonstrate that the project team has the professional expertise and mix of skills to successfully complete all three phases of the Statement of Work. Particular emphasis would be placed on the qualifications of the Project Manager and senior members of all participating organizations.

4.2.4 Soundness of Approach

Emphasis would be placed on the proposed Work Plan for Phase I and the overall project, the sequence and relationships of major steps to be performed, the reasonableness of the proposed schedule, the appropriateness of the roles of all organizations on the proposer's team, and the proposed methods for managing the project.

4.3 Cost Proposal Evaluation

Proposed costs for Phase I would not be evaluated on a point basis, but on cost realism, and would be subordinate to technical considerations. In evaluating the cost proposal, the Pennsylvania Energy Office's primary concern would be to determine whether the costs are based on adequate estimating procedures and are realistic and reasonable in terms of the proposed technical approach and work plan for Phase I.

ATTACHMENT A

RECOMMENDED STATEMENT OF WORK

This project consists of three Phases. At the conclusion of each phase, the PEO will formally evaluate the achievements and progress towards developing a high performance anthracite boiler system for applications in the commercial sector. The proposer must discuss its capabilities and approach for performing all three Phases.

1. Phase I -- Total System Design Competition

1.1 Task I.1 -- System Design

The contractor shall develop a preliminary engineering design of a high-performance, anthracite-fired commercial boiler system with a firing rate of between 2 and 4 million Btus per hour. The system shall be designed to produce hot water and/or low pressure steam for the purpose of meeting building heating requirements. The system shall be fueled with a prepared anthracite of a grade that is commonly available in the Pennsylvania anthracite mining area. The preliminary engineering design will encompass the full boiler system as defined in Section 1.4 of the RFP. In the event that data or information are incomplete to support the preliminary engineering design, the contractor will make appropriate and necessary assumptions, based upon best engineering judgement and professional practice. At a minimum, the engineering design will include:

- Complete block flow diagrams of the system, including heat and material balances
- Engineering drawings of all subsystems and major components that are not commercially available, and a detailed description of all control systems
- A description of a possible layout for the system, accompanied by a drawing of the layout
- A list of all operational uncertainties and of all equipment whose design is uncertain or undemonstrated
- A description of system operation, including cold-start, load following, and shut-down
- An estimate of the costs of fabricating major subsystems and installing the entire system, assuming economies of production as opposed to a one-of-a-kind system

1.2 Task I.2 -- Phase II Plan

The contractor shall prepare a plan for performing all Phase II tasks. The plan should include component development and testing (Task II.2) required to address the equipment and performance uncertainties identified in the preliminary engineering design and allow assembly and operation of a completely integrated anthracite boiler system. The Phase II plan shall include the following:

- A breakdown of the proposed laboratory research and equipment testing in Task II.2 into logical subtasks, and a statement of the technical objectives and approach for each subtask; and
- Organization, schedule, manpower and detailed cost plans for all Phase II tasks.

1.3 Task I.3 -- Final Phase I Report

The contractor shall prepare and submit to the Pennsylvania Energy Office a Draft Phase I Report covering all work performed in Phase I. The report should specifically address the benefits offered by the designed system, covering topics such as ease of use, compatibility with user constraints (e.g., space and manpower), cost effectiveness, efficiency, and environmental performance. The Pennsylvania Energy Office shall have fifteen calendar days to comment on the Draft Phase I Report. Within twenty calendar days of receiving the Pennsylvania Energy Office comments, the contractor shall prepare and submit ten copies of the Final Phase I Report.

2. Phase II -- Component Development and Testing

Upon Written notification by the Pennsylvania Energy Office, the contractor shall proceed to Phase II of the project, which consists of the following tasks:

2.1 Task II.1 -- Project Work Plan

The contractor shall prepare and submit to the Pennsylvania Energy Office, within thirty calendar days after notification to proceed to Phase II, a Draft Phase II Work Plan, based upon the plan prepared in Phase I and revised to reflect the Phase II budget and schedule, as established by the Pennsylvania Energy Office. The Pennsylvania Energy Office will have fifteen calendar days to return comments on the Draft to the contractor. Within fifteen calendar days of receiving the Pennsylvania Energy Office comments, the contractor shall prepare and submit a Final Phase II Work Plan and, upon the Pennsylvania Energy Office's approval of the Final plan, begin the remaining Phase II tasks.

2.2 Task II.2 -- Research and Development

The Contractor shall implement laboratory research and equipment development and testing in accordance with the Final Phase II Work Plan.

2.3 Task II.3 -- Site Selection

The contractor shall select a site for the on-site demonstration and evaluation of an integrated commercial anthracite boiler system. Site selection will include securing the cooperation of the site owners, investigating all permitting requirements, and assessing opportunities for cost-sharing during Phase III.

2.4 Task II.4 -- Final Engineering Design

Based on the results of Task II.2, the contractor will revise the Preliminary Engineering Design developed in Task I.1 and develop a site-specific final engineering design for the on-site demonstration.

2.5 Task II.5 -- Phase III Work Plan

The contractor shall prepare a plan for the performance of all Phase III tasks. The plan should explicitly identify materials and equipment to be purchased and develop a process for competitively selecting equipment manufacturers.

2.6 Task II.6 -- Final Phase II Report

The contractor shall prepare and submit to the Pennsylvania Energy Office a Draft Phase II Report covering all work performed in Phase II. A Final Phase II report will be submitted in accordance with the procedures described in Task I.3.

3. Phase III -- On-Site Demonstration

Upon written notification by the Pennsylvania Energy Office, the contractor shall proceed to Phase III of the project, which consists of the following tasks:

3.1 Task III.1 -- Installation

In accordance with the Phase III Work Plan, the contractor shall install an integrated anthracite boiler system with a firing rate between 2 and 4 million Btus per hour.

3.2 Task III.2 -- Operation and Evaluation

In accordance with the Phase III Work Plan, the contractor shall be responsible for the operation of the installed boiler system for a period of at least one year. As necessary, the contractor will modify the system to improve performance and/or reliability. The contractor shall monitor operations and conduct measurements required to develop a complete evaluation of the system's performance.

3.3 Task III.3 -- Final Report

The contractor shall prepare a Draft Final Report covering all three phases of the project. For Phases I and II, the report shall summarize major achievements and results. For Phase III, the report will document in detail the design and operation of the anthracite boiler system and thoroughly discuss major design and operational issues. A Final Report will be submitted in accordance with the procedures described in Task I.3.