DOE/FE-0265P
Distribution Category UC-101

Comprehensive Report to Congress Clean Coal Technology Program

Milliken Clean Coal Technology Demonstration Project

A Project Proposed By:
New York State Electric & Gas Corporation

U.S. Department of Energy
Assistant Secretary For Fossil Energy
Office of Clean Coal Technology
Washington, D.C. 20585

September 1992

TABLE OF CONTENTS

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

Public Law No. 101-121 provided $600 million to conduct cost-shared Clean Coal Technology (CCT) projects to demonstrate technologies that are capable of replacing, retrofitting, or repowering existing facilities. Toward that end, a Program Opportunity Notice (PON) was issued by the Department of Energy (DOE) in January 1991. This PON solicited proposals to demonstrate innovative, energy efficient technologies that were capable of being commercialized in the 1990s. These technologies were to be capable of (1) achieving significant reductions in the emissions of sulfur dioxide and/or nitrogen oxides from existing facilities to minimize environmental impacts, such as transboundary and interstate pollution, and/or (2) providing for future energy needs in an environmentally acceptable manner.

In response to the PON, 33 proposals were received by DOE in May 1991. After evaluation, nine projects were selected for award. These projects involved both advanced pollution control technologies that can be "retrofitted" to existing facilities and "repowering" technologies that not only reduce air pollution but also increase generating plant capacity and extend the operating life of the facility.

One of the nine projects selected for funding is a project proposed by the New York State Electric & Gas Corporation (NYSEG) called the Milliken Clean Coal Technology Demonstration (MCCTD). This project will provide full-scale demonstration of a combination of innovative emission-reducing technologies and plant upgrades for the control of sulfur dioxide (SO_2) and nitrogen oxides (NO_x) emissions from a coal-fired steam generator, without a significant loss of efficiency.

The overall project goals are:

- To achieve 98% SO_2 removal efficiency using limestone while burning high-sulfur coal.

- To achieve up to 70% NO_x reductions using the NO_xOUT\ selective non-catalytic reduction (SNCR) technology in conjunction with combustion modifications.

- To minimize solid wastes by producing marketable by-products (commercial-grade gypsum, calcium chloride, and fly ash).

- To achieve zero wastewater discharge.

- To maintain station efficiency by using a high efficiency air heater system and a low power consuming scrubber system.

The Saarberg-Hölter Umwelttechnick (S-H-U) process will be used to reduce SO_2 emissions by up to 98%. In the S-H-U process, the flue gas is scrubbed with a limestone slurry in an absorber vessel that does not contain packing or grid work. The lack of packing results in a low pressure drop across the absorber, which decreases energy requirements. The S-H-U slurry is maintained at a low pH by adding formic acid, which acts as a buffer, to the limestone slurry. A slipstream is processed for recovery of high-quality by-product gypsum and calcium chloride. Water is recovered and recycled to the process. This will be the first U.S. demonstration of the S-H-U process and will include the innovative feature of a tile-lined, split-flow absorber constructed below the flues.

NO_x emissions will be reduced by a combination of combustion modifications and the installation of the NO_xOUT\ urea injection technology. The NO_xOUT\ technology is capable of reducing NO_x emissions without affecting the salability of the flyash.

In order to maintain plant efficiency, a high efficiency heat pipe or heat plate air heater system will be installed. A heat pipe unit uses carefully selected liquids, sealed in tubes, as the heat transfer medium. One portion of each tube is in the flue gas stream and the rest of the tube is in the air stream. The liquid in the tube evaporates in the hot portion; then the vapor flows to the cold end, where it condenses; and the liquid flows back to the hot end. A heat plate air heater is constructed from a series of alternating flue gas and combustion air passages. The gas passages are narrow and share common walls with heat transfer occurring by conduction across the faces of the walls. The need for special air seals and the associated potential for air heater leakage is eliminated with this design. Because of the high efficiency of these units, the temperature of the combustion air will be increased, which will increase the efficiency of the plant.

The demonstration project will be conducted at NYSEG's Milliken Station, located at Lansing, New York. The Milliken Station comprises two 150 MWe pulverized-coal-fired units, built in the 1950s by Combustion Engineering. The S-H-U Flue Gas Desulfurization (FGD) process and the combustion modifications will be installed on both units, but the NO_xOUT\ process and the high efficiency air heater system will be installed only on Unit 2.

This demonstration will be conducted over 69 months. Project activities will include design and engineering, construction, start-up, and operations.

The total project cost is $158,607,807. The DOE's share is $45,000,000. The co-funder is NYSEG, whose share is $113,607,807. Operations are scheduled to begin in mid-1995. The project is scheduled to be completed in the first quarter of 1998.

2.0 INTRODUCTION AND BACKGROUND

2.1 Requirement for a Report to Congress

On October 23, 1989, Congress made available funds for the fourth clean coal demonstration program (CCT-IV) in Public Law 101-121, "An Act Making Appropriations for the Department of the Interior and Related Agencies for the Fiscal Year Ending September 30, 1990, and for Other Purposes" (the "Act"). Among other things, this Act appropriates funds for the design, construction, and operation of cost-shared, clean coal projects to demonstrate the feasibility of future commercial applications of such "... technologies capable of replacing, retrofitting or repowering existing facilities ...." On November 5, 1990, Public Law 101-512 was signed into effect, requiring "a general request for proposals for CCT-IV by no later than February 1, 1991, and to make selections of projects for negotiations no later than eight months after the date of the general request for proposals."

Public Law 101-121 appropriates a total of $600 million for executing CCT-IV. Of this total, $7.2 million are required to be reprogrammed for the Small Business and Innovative Research Program (SBIR), and $25.0 million are designated for Program Direction Funds for costs incurred by DOE in implementing the CCT-IV program. The remaining $567.8 million was available for award under the PON.

The purpose of this Comprehensive Report is to comply with Public Law 101-512, which directs the Department to prepare a full and comprehensive report to Congress on each project selected for award under the CCT-IV program.

2.2 Evaluation and Selection Process

DOE issued a draft PON for public comment on November 20, 1990, receiving a total of 19 responses from the public. The final PON was issued on January 15, 1991, and took into consideration the public comments received on the draft PON. DOE received 33 proposals in response to the CCT-IV solicitation by the May 17, 1991, deadline.

2.2.1 PON Objective

As stated in PON Section 1.2, the objective of the CCT-IV solicitation was to obtain "proposals to conduct cost-shared Clean Coal Technology projects to demonstrate innovative, energy efficient, economically competitive technologies that are capable of being commercialized in the 1990s. These technologies must be capable of (1) retrofitting, repowering or replacing existing facilities while achieving significant reductions in the emissions of sulfur dioxide and/or the oxides of nitrogen and/or (2) providing for future energy needs in an environmentally acceptable manner."

2.2.2 Qualification Review

The PON established seven Qualification Criteria and provided that, "in order to be considered in the Preliminary Evaluation Phase, a proposal must successfully pass Qualification." The Qualification Criteria were as follows:

(a) The proposed demonstration project or facility must be located in the United States.

(b) The proposed demonstration project must be designed for and operated with coal(s), and these coals must be from mines located in the United States.

(c) The proposer must agree to provide a cost share of at least 50% of total allowable project costs, with at least 50% in each of the three project phases.

(d) The proposer must have access to, and use of, the proposed site and any proposed alternate site(s) for the duration of the project.

(e) The proposed project team must be identified and firmly committed to fulfilling its proposed role in the project.

(f) The proposer agrees that, if selected, it will submit a "Repayment Plan" consistent with PON Section 7.7.

(g) The proposal must be signed by a responsible official of the proposing organization, authorized to contractually bind the organization to the performance of the Cooperative Agreement in its entirety.

2.2.3 Preliminary Evaluation

The PON provided that a Preliminary Evaluation would be performed on all proposals that successfully passed the Qualification Review. In order to be considered in the Comprehensive Evaluation phase, a proposal must be consistent with the stated objectives of the PON and must contain sufficient information on finance, management, technical, cost, and other areas to permit the Comprehensive Evaluation described in the solicitation to be performed.

2.2.4 Comprehensive Evaluation

The Technical Evaluation Criteria were divided into two major categories: (1) the Demonstration Project Factors were used to assess the technical feasibility and likelihood of success of the project, and (2) the Commercialization Factors were used to assess the potential of the proposed technology to reduce emissions from existing facilities, as well as to meet future energy needs through the environmentally acceptable use of coal, and the cost effectiveness of the proposed technology in comparison to existing technologies.

The Cost and Finance Evaluation criteria were used to determine the business performance potential and commitment of the proposer.

The PON provided that the Cost Estimate would be evaluated to determine the reasonableness of the proposed cost. Proposers were advised that this determination "...will be of minimal importance to the selection..." and that a detailed cost estimate would be requested after selection. Proposers were cautioned that if the total project cost estimated after selection is greater than the amount specified in the proposal, DOE would be under no obligation to provide more funding than had been requested in the proposer's original Cost Sharing Plan.

2.2.5 Program Policy Factors

The PON advised proposers that the following program policy factors could be used by the Source Selection Official to select a range of projects that would best serve program objectives:

(a) The desirability of selecting projects that collectively represent a diversity of methods, technical approaches, and applications.

(b) The desirability of selecting projects in this solicitation that contribute to near-term reductions in transboundary transport of pollutants by producing an aggregate net reduction in emissions of sulfur dioxide and/or nitrogen oxides.

(c) The desirability of selecting projects that collectively utilize a broad range of U.S. coals and are in locations which represent a diversity of EHSS, regulatory, and climatic conditions.

(d) The desirability of selecting projects in this solicitation that achieve a balance between (1) reducing emissions and (2) providing for future energy needs by the environmentally acceptable use of coal or coal-based fuels.

(e) The desirability of selecting projects that provide strategic and energy security benefits for remote, import-dependent sites, or that provide multiple fuel resource options for regions which are considerably dependent on one fuel form for total energy requirements.

The word "collectively," as used in the foregoing program policy factors, was defined to include projects selected in this solicitation and prior clean coal solicitations, as well as other ongoing demonstrations in the United States.

2.2.6 Other Considerations

The PON stated that, in making selections, DOE would consider giving preference to projects located in states for which the rate-making bodies of those states treat the clean coal technologies the same as pollution control projects or technologies. This consideration could be used as a tie breaker if, after application of the evaluation criteria and the program policy factors, two projects received identical evaluation scores and remained essentially equal in value. This consideration would not be applied if, by so doing, the regional geographic distribution of the projects selected would be significantly altered.

2.2.7 National Environmental Policy Act (NEPA) Compliance

As part of the evaluation and selection process, the Clean Coal Technology Program developed a procedure for compliance with the National Environmental Policy Act of 1969 (NEPA), the Council on Environmental Quality NEPA regulations (40 CFR 1500-1508), and the DOE guidelines for compliance with NEPA (52 FR 47662, December 15, 1987). DOE final NEPA regulations replacing the DOE guidelines were published in the Federal Register on April 24, 1992, (57 FR 15122). This procedure included the publication and consideration of a publicly available Final Programmatic Environmental Impact Statement (DOE/EIS-0146), issued in November 1989, and the preparation of confidential preselection project-specific environmental reviews for internal DOE use. DOE also prepares publicly available site-specific documents for each selected demonstration project as appropriate under NEPA.

2.2.8 Selection

After considering the evaluation criteria, the program policy factors, and the NEPA strategy as stated in the PON, the Source Selection Official selected nine projects as best furthering the objectives of the CCT-IV PON. These selections were announced on September 12, 1991, during a press conference.

3.0 TECHNICAL FEATURES

3.1 Project Description

NYSEG will demonstrate the reduction of SO_2 and NO_x emissions without a significant decrease in plant efficiency by installing a combination of innovative technologies and plant upgrades. These include the Saarberg-Hölter Umwelttechnick (S-H-U) process for SO_2 reduction, combustion modifications and the NO_xOUT\ process for NO_x reduction, and a high efficiency air heater system plus other energy-saving modifications to maintain efficiency. This project will be the first U.S. demonstration of the S-H-U process, which will include the first demonstration of a tile-lined, split-flow absorber below the flues. This project will also be the first demonstration of the NO_xOUT\ process in a utility furnace firing high-sulfur coal, as well as the first application of a high efficiency air heater system with CAPCIS corrosion monitoring in a coal-fired furnace.

This project will be conducted at NYSEG's Milliken Station in Lansing, New York, as shown in Figure 1. This plant is one of the top 20 most efficient steam electric generating stations operating in the United States. If successful, this project will achieve significant reductions in acid gas emissions with virtually no change in station efficiency. It will further demonstrate that this technology is technically and economically viable in a retrofit application and will provide cost and performance data from a commercial-scale application to demonstrate the viability of the technology for new boilers.

The overall project goals are:

- To achieve 98% SO_2 removal from the flue gas, using limestone, while burning high-sulfur coal.

- To achieve up to 70% NO_x reduction using the NO_xOUT\ selective non-catalytic reduction (SNCR) technology in combination with combustion modifications.

- To minimize solid wastes by producing marketable by-products (commercial-grade gypsum, calcium chloride, and flyash).

- To achieve zero wastewater discharge.

- To maintain station efficiency by using a high efficiency air heater system and a scrubber system with low power requirements.

The S-H-U process is the only developed wet limestone flue gas desulfurization (FGD) process which is designed specifically to employ the combined benefits of low-pH operation; formic acid enhancement; single loop, cocurrent/countercurrent absorption; and in-situ forced oxidation. The unique cocurrent/countercurrent absorber does not include any packing or grid work. This significantly reduces the potential for plugging and erosion and reduces the energy consumption of the boiler and induced draft (I.D.) fans.

This project will demonstrate the following features of the S-H-U FGD process:

- up to 98% SO_2 removal efficiency with limestone,
- low limestone reagent consumption,
- excellent stability and easy operation during load changes and transients,
- low production of scrubber blowdown,
- freedom from scaling and plugging,
- high availability,
- low maintenance,
- production of wallboard-grade gypsum and commercially usable calcium chloride by-products, and
- improved energy efficiency compared with conventional FGD technologies.

This project will provide the first demonstration of the S-H-U process installed directly below the flues. This design approach saves considerable space on site and is advantageous for existing plants, where space for retrofitting an FGD process is at a premium.

The S-H-U FGD process will be installed on both Units 1 and 2 with common auxiliary equipment. A single split absorber will be used. This innovation features an absorber vessel that is divided into two sections to provide a separate absorber module for each unit. This design allows for more flexibility in power plant operations than a single absorber, while saving space and being cheaper than two separate absorbers.

An additional feature to be demonstrated is the use of a tile-lined absorber. The tile lining has superior abrasion and corrosion resistance, when compared with rubber and alloy linings, and is expected to last the life of the plant. In addition, the tile is easily installed at existing sites, where space for construction is at a premium, making it ideal for use in retrofit projects.

Unlike some competing processes that produce gypsum, the S-H-U by-product gypsum will be of excellent and consistent quality, regardless of the plant load level or flue gas sulfur dioxide level. To provide a more marketable product, the gypsum will be agglomerated for easy transportation to the purchaser.

This project will also be the first demonstration of the production and marketing of by-product calcium chloride. The brine concentration system will allow the S-H-U blowdown stream to be purified and recycled to the plant as FGD make-up water. The calcium chloride produced from the brine concentration system will be a commercially marketable product and will be sold as a solution or spray dried and sold as a powder, depending on the needs of the purchaser.

The project will install combustion modifications at NYSEG's expense on both units for primary NO_x emission control. While not proposed for DOE funding, combustion modifications are an integral part of the project, since they reduce NO_x levels by about 20%. In addition, the NO_xOUT\ technology will be installed on Unit 2 to provide a further reduction in NO_x emissions over that achieved by the combustion modifications alone. The NO_xOUT\ process achieves NO_x reduction by the reaction of NO_x with urea injected into the post-combustion zones of the boiler.

The installation of the NO_xOUT\ technology will allow this project:

- To demonstrate a NO_x emissions reduction of 30% or more over that achieved with combustion modifications alone.

- To demonstrate cost effectiveness for NO_x reduction.

- To determine the effect of these NO_x reduction technologies on air heater, electrostatic precipitator (ESP), and scrubber operations and on fly ash quality.

Another component of the project is the addition of a high efficiency air heater system, along with other equipment modifications, to maintain the station efficiency, while SO_2 and NO_x emissions are significantly reduced. The CAPCIS corrosion monitoring system will be used in conjunction with the high efficiency air heater system to control flue gas discharge temperature and prevent acid corrosion due to condensation.

Figure 2 presents a block flow diagram of the MCCTD project.

3.1.1 Project Summary

Project Title:	Milliken Clean Coal Technology Demonstration Project
Proposer:	New York State Electric & Gas Corporation
Project Location:	Milliken Station Lansing, New York Tompkins County
Technology:	A combination of limestone scrubbing, combustion modifications, urea injection, and enhanced heat recovery to reduce SO_2 and NO_x emissions while *maintaining efficiency*
Application:	SO_2 and NO_x emissions reductions in pulverized-coal-fired furnaces
Type of Coal Used:	High-sulfur bituminous (Pittsburgh seam)

Product:	Pollution Control Technology
Project Size:	300 MWe
Project Start Date:	1992
Project End Date:	1998

3.1.2 Project Sponsorship and Cost

Project Sponsor: New York State Electric & Gas Corporation

Estimated Project Cost: $158,607,807

Estimated Cost Distribution:	Participant Share (%)	DOE Share (%)
	71.63	28.37

3.2 Milliken Clean Coal Technology

3.2.1 Overview of Technology Development

Saarberg-Hölter Umwelttechnik GmbH was formed in Germany in the mid-1970s as a joint venture between Saarbergwerke AG, an electric utility, and Hölter GmbH, an engineering company, and was assigned the task of developing an FGD process that would have high SO_2 removal efficiency, high reliability, and low maintenance, while producing a marketable by-product.

Laboratory-scale experiments indicated that organic acids enhanced SO_2 removal in calcium-based FGD systems. A 40 MW demonstration plant was installed at Saarberg's Weiher II power station, followed by a 175 MW commercial unit at the Weiher III station in 1979. These installations were designed to use a lime slurry, buffered with formic acid addition, as the reagent for SO_2 absorption. The absorbers were of high-velocity, cocurrent, venturi-throat design with 85% removal efficiencies. A separate oxidizer tank for sulfite oxidation and a thickener for primary dewatering were installed. Although these plants were successful in operation, the operating costs were high, due to the high pressure drop across the absorber and high lime prices.

In 1982, a second unit at Weiher III was commissioned utilizing a cocurrent type absorber and limestone as the reagent, and 90% SO_2 removal efficiency was achieved. As a result of the experience gained from the first unit at Weiher III, the oxidation step was integrated into the absorber sump, and the thickener was eliminated. A similar design was installed at the Saarberg Bexbach station. More stringent acid rain legislation was passed in Germany in 1982. To meet the new limits, all subsequent S-H-U installations utilized a combination cocurrent/countercurrent absorber designed to achieve 95% SO_2 removal efficiency. The system has been demonstrated on single modules of 125 to 550 MW, firing low-sulfur bituminous coal, oil, and lignite fuels. The system has also been demonstrated successfully on two 20 MW stations in Turkey burning 8% sulfur lignite. S-H-U units have experienced reliabilities greater than 98%.

The FGD absorber will be constructed of reinforced concrete lined with Stebbins tile. Reinforced concrete vessels lined with Stebbins' proprietary SEMPLATE ceramic tile are commonly used in corrosive services in the pulp and paper, chemical, and mining industries, but application of this technology to FGD absorbers has been limited. This method of construction was developed in the early 1930s by Stebbins. Since then, they have constructed thousands of vessels. During the last few years, Stebbins has completed many projects in the power industry, including both retrofit linings and new construction. Stebbins successfully designed and installed four M.W. Kellogg horizontal-weir type scrubbers of reinforced concrete, SEMPLATE ceramic tile construction at Big Rivers Electric's D.B. Wilson Generating Station in Centertown, KY. The first three modules were completed in 1982, and the fourth was installed in 1986.

The concept of constructing an absorber module below the flue has been demonstrated at the 220 MW coal-fired Mellach Generating Station, located near the City of Grax in southeast Austria. The plant burns a variety of coals with sulfur contents ranging from 0.3% to 2.0%. The FGD process uses wet limestone in an open countercurrent spray tower and produces commercial-grade gypsum. The cylindrical spray tower and its accessories, including the slurry recycle pumps, are located inside the enlarged base of the stack. The plant went into commercial operation in 1986 and has since operated satisfactorily, meeting or exceeding SO_2 removal efficiency and system reliability guarantees.

The NO_xOUT\ SNCR process is licensed by Nalco Fuel Tech, a joint venture formed in 1990 by Nalco Chemical Co. and Fuel Tech N.V. Nalco Fuel Tech was formed to link a large chemical company having extensive utility and boiler experience with a technology that reduces air pollution in a highly effective, highly reliable manner without causing detrimental effects to the combustion equipment. Fuel Tech N.V. has performed research on enhancements of the urea injection concept initiated by the Electric Power Research Institute (EPRI) in 1976 and developed proprietary chemicals to permit urea injection over a broader temperature range and perfected the injection equipment and process configuration. In 1987, Fuel Tech became the exclusive agent for EPRI's urea injection technology, and Nalco Fuel Tech is the exclusive licensing agent of this technology.

The NO_xOUT\ process was first commercially applied on a corner-fired utility boiler owned by Rheinisch-Westfalisches Elektrizitatswerk, a German utility. In 1987, a number of tests for NO_x reduction were initiated on a 150 MW, lignite-fired boiler at the Weisweiler Plant. The test objectives of up to 50% NO_x reduction and an ammonia slip of less than 5 ppm were met over a range of operating conditions. In 1988, a commercial NO_xOUT\ system was installed on a 75 MW, lignite-fired boiler which had achieved a NO_x emissions level of 150 ppm by the use of combustion modifications. Using the NO_xOUT\ technology, NO_x emissions were further reduced to 90-98 ppm, and ammonia slip was controlled to a level of less than 2 ppm.

By 1991, NO_xOUT\ technology was installed or in the planning stages on 30 boilers, with capacities ranging from 130 million Btu/hr to 900 million Btu/hr. The boilers include stokers and corner- and wall-fired furnaces. Fuels have included gas, wood, tires, municipal solid waste, oil, lignite, and low-sulfur bituminous coals. Commercialization of this technology for more tightly designed boilers or those firing high-sulfur coals has not begun, nor have any substantial demonstration tests been performed on coal-fired boilers in the U.S.

Either a heat pipe air heater or a heat plate air heater will be installed as part of this project. Heat pipe air heaters have been used in smaller coal fluidized-bed, gas, and oil boilers. Over 100 heat pipe air heaters have been installed, mostly on smaller industrial boilers and fired heaters. Many have been in operation for over 10 years. To date, the most relevant utility installation of heat pipe air heaters is at West Penn Power's Pleasant Station in Willow Island, WV, a 626 MW unit. The heat pipe system has a capacity of 39.2 million Btu/hr, which is approximately half the size of the unit for the MCCTD project. The fuel used at Pleasant Station is Pittsburgh seam coal with a 3.2% sulfur content. The heat pipe system has been in service for over 7 years with excellent results, and it was over 4 years before the fins needed to be washed. The utility is very pleased with the heat pipe system's performance, especially the low maintenance and lack of leakage. The application of a heat plate air heater to a coal-fired utility boiler is a new concept, and no examples of this technology exist in the U.S.

During the past 12 years, numerous CAPCIS corrosion monitoring and surveillance systems have been installed around the world. Most of the early applications were used to investigate corrosion in low-temperature acidic condensation systems. Since 1980, CAPCIS has been working on the investigation of condensation corrosion in the low-temperature sections of a boiler plant. More recently, CAPCIS has developed systems for monitoring in high temperature (up to 2000°F) environments, such as in combustion units and process heaters.

3.2.2 Process Description

The technology being demonstrated in this project is a combination of wet limestone scrubbing for SO_2 removal using the S-H-U FGD process, combustion modifications and urea injection for NO_x control using the NO_xOUT\ process, and installation of a high efficiency air heater system and other modifications for efficiency improvement. The integration of these technologies provides a means to meet Clean Air Act Amendment (CAAA) goals while maintaining plant efficiency.

3.2.2.1 S-H-U FGD Process

Figure 3 is a simplified flow diagram of the S-H-U FGD absorber. Flue gas from the I.D. fans enters at the top of the cocurrent section of the absorber, passes through this section and then through the countercurrent section. In both of these sections it is contacted with recycled limestone slurry to absorb SO_2. The limestone slurry is introduced by spray nozzles at four levels in the cocurrent section (three plus a spare) and at three levels in the countercurrent section (two plus a spare). The flue gas then passes through a two-stage mist eliminator to remove entrained water droplets before discharge to the new wet chimney. The bottom of the absorber is utilized as a slurry sump, collecting reacted and unreacted slurry droplets from the spray headers and mist eliminators and fresh slurry make-up. A constant flow of slurry from the absorber sump is bled off to process gypsum and control cycle chemistry. The system is designed for 95% SO_2 removal when firing 3.2% sulfur coal at design flue gas rates with only five of the seven spray levels in operation.

Some oxidation occurs in the absorber from excess oxygen in the flue gas. Air is injected into the absorber sump to complete oxidation of the absorption product (calcium bisulfite) to gypsum (calcium sulfate). Agitators provide complete mixing of air and slurry and prevent gypsum particles from settling to the bottom. The slurry in the absorber sump contains approximately 10% gypsum, which provides seed crystals for the formation of gypsum particles. This eliminates uncontrolled gypsum growth on absorber internals that may occur in competing scrubber systems. The slurry bled from the absorber sump is pumped to the hydrocyclones. Underflow slurry from the hydrocyclones is sent to vacuum belt filters which produce a gypsum cake which is transported to an agglomerater.

All the water in the system is recycled; and, to purge absorbed chloride from the slurry system, part of the clarified water is treated to produce marketable $CaCl_2$. The rest of the clarified water is pumped to the reagent preparation system.

Limestone from storage silos is conveyed to the wet tower mill for size reduction. Clarified water is pumped to the mills to be used as grinding and dilution water. Limestone slurry is continuously pumped to the absorber.

The FGD absorber is a concrete vessel with tile lining that has a common center dividing wall to provide each unit with its own absorber. Since each side of the vessel operates independently of the other, this split module design allows the flue gas from each boiler to be independently treated at a lower capital cost than would be required for the construction of two separate vessels. The split module design concept also provides the plant with greater operating flexibility and reliability than a single large module. The absorber and its related equipment are located below the flues. Constructing the scrubber below the flues saves plot area.

3.2.2.2 NO_xOUT\ Process

The NO_xOUT\ process, offered by Nalco Fuel Tech, is a new urea-based chemical and mechanical system for cost-effective NO_x reduction from fossil- and waste-fueled combustion sources. The NO_xOUT\ process reduces NO_x levels by injecting urea into the post-combustion zones of the boilers, as shown in Figure 4. Urea is an effective agent for converting NO_x into harmless nitrogen, carbon dioxide, and water, by the following reactions:

$$2NO + CO(NH_2)_2 + 1/2\ O_2 \dashrightarrow 2N_2 + CO_2 + 2H_2O$$
$$2NO_2 + 2CO(NH_2)_2 + O_2 \dashrightarrow 3N_2 + 2CO_2 + 4H_2O$$

These reactions take place only in the narrow temperature range of 1600°F to 2100°F, below which ammonia is formed, and above which NO_x emission levels actually increase. However, the NO_xOUT\ process uses patented chemical enhancers and mechanical modifications to widen the temperature range over which the process is effective and to control the formation of ammonia.

The NO_xOUT\ process includes:

- o Proprietary computer model codes to ensure that the NO_xOUT\ chemicals are optimally distributed in the boiler.
- o Control hardware and software to enable the NO_xOUT\ process to follow boiler load changes by altering the flow rate and injection point of the urea-based reagents.
- o Chemical feed, storage, mixing, metering, and pumping systems.

3.2.2.3 High Efficiency Air Heater System

Demonstration of the energy savings provided by a high efficiency air heater system is another feature of this project. Either a heat pipe air heater or a heat plate air heater will be installed. Heat pipe air heaters and heat plate air heaters are designed to provide enhanced air heater performance compared to the air heater technology commonly found in utility boiler applications. Both the heat pipe and heat plate air heater systems are designed to eliminate air heater leakage and reduce exit gas temperatures, and either option will be satisfactory to demonstrate improved air heater efficiency.

Heat pipe air heaters, as shown in Figure 5, transfer heat from the boiler flue gas to the boiler combustion air using an intermediate heat transfer fluid. The heat transfer fluid is sealed inside individual heat transfer tubes that are closed at each end, as shown in Figure 6. The tubes are installed with one portion of the tube in the flue gas stream and one portion in the air stream. Each tube provides a closed-loop evaporation/condensation cycle that is driven by the temperature difference between the hot flue gas and the cold combustion air supply. A large quantity of heat can be transferred by a small amount of fluid, up to several thousand times as much as solid copper, even with only small temperature differences.

Heat plate air heaters, as manufactured by Balcke-Dürr and shown in Figure 7, transfer heat from the boiler flue gas to the boiler combustion air in a recuperative plate-type heat exchanger based on a counterflow principle. This system is a further development of the proven crossflow plate-type heat exchanger already used on a smaller scale. Like the heat pipe, the heat plate air heater is also free of leakage between the flue gas and air flows. The heat plate air heater has additional benefits, such as compact construction, low pressure drops, and, because the heat exchange modules are accessible, easier cleaning and maintenance.

Milliken Station Unit 2's existing air heaters, which are Ljungstrom regenerative-type air heaters, will be replaced with a high efficiency air heater system. The replacement provides energy savings by eliminating air leakage across the air heater and by lowering average exit gas temperature. For every 35°F drop in flue gas temperature, plant efficiency increases by approximately 1%; thus the incentive is great to install a high efficiency air heater system. The high efficiency air heater system will also utilize the CAPCIS corrosion monitoring system and air heater bypass system to control the air heater discharge temperature. This project will demonstrate the energy efficiency and conservation gains achievable by incorporating this total system.

3.2.2.4 Other Modifications

Other system modifications that are necessary to demonstrate the features of the project technologies are as follows:

- o Installation of new coal mills for both Units 1 and 2 to allow firing of a wide range of high-sulfur eastern coals. The existing coal mills cannot grind the harder high-sulfur coals fine enough to prevent an unacceptable increase of carbon carryover from the boilers. The resulting high-carbon fly ash, collected in the ESP's, would not be marketable, which would lead to a large increase in solid waste from the project.

- o Upgrades to the ESP's to ensure that the maximum allowable particulate loading at the FGD inlet is not exceeded and that commercial gypsum specifications are met.

- o Combustion modifications (funded completely by NYSEG) to reduce NO_x emissions approximately 20% below current levels.

- o Boiler control upgrades (funded completely by NYSEG) to provide reliable operations during the demonstration. These upgrades will increase the reliability of test results by improving data acquisition and decreasing interference from boiler operating disturbances.

- o New seals for the Unit 1 Ljungstrom air heater (at NYSEG's cost) to provide a valid comparison of the high efficiency air heater system on Unit 2 with the more conventional air heater on Unit 1.

3.2.3 Application of Technology in Proposed Project

NYSEG will conduct this demonstration at its Milliken Station in Lansing, New York. There are two units, Unit 1 and Unit 2, at Milliken Station. These units are pulverized coal-fired units, built by Combustion Engineering and rated at a nominal 150 MW each, which operate under balanced-draft mode. Each unit is tangentially fired with four elevations of burners at each of the four corners. Unit 1 was completed in 1955, and Unit 2 was completed in 1958.

Some of the technologies will be demonstrated on both units, while other technologies will be demonstrated on only Unit 2. The S-H-U process will be installed on both Units 1 and 2, and the units will share a unique below the flues, split absorber to demonstrate the advantages of this design. The combustion modifications and improved boiler controls will also be installed on both units. A computer model will be used to optimize the design of the combustion retrofit components.

Unit 2 will be further modified to incorporate a unique combination of features, including a high efficiency air heater system with temperature control for improved energy efficiency and energy conservation and a CAPCIS corrosion monitoring system and the NO_xOUT\ selective non-catalytic reduction system. Thus, all features of the MCCTD project will be demonstrated on Unit 2. Incorporation of this combination of innovative technologies into one unit will demonstrate excellent pollution abatement with a high level of energy efficiency and conservation that is not possible with many competing technologies.

3.3 General Features of the Project

3.3.1 Evaluation of Developmental Risk

As described in Section 3.2.1, all the aspects of the MCCTD project have been proven to varying extents. However, with any developing technology some risks are involved.

Based on successful operating data from applications involving combustion of low/medium-sulfur fuels in commercial plants and high-sulfur fuel in a pilot plant, the technical risk of failing to demonstrate 95% SO_2 removal efficiency and 95% reliability of the S-H-U FGD technology is small. Spare limestone slurry recycle pump capacity will be provided to mitigate this risk and to provide the ability to demonstrate very high SO_2 removal efficiencies of approximately 98% on a variety of coals.

The major risk associated with employing the Stebbins' tile/reinforced concrete design concerns potential corrosion of the concrete and rebar, due to leakage through cracks in the tiles or deteriorated mortar. To handle leaks, Stebbins has devised a repair method based on visual detection of a leak, drilling a hole from outside of the vessel, and pumping sealant through the hole to seal the leak. Since repairs to the external walls may be safely made while the unit is in operation, unscheduled shutdown for leaks should not be required. In addition, inspection and repointing, if necessary, of the mortar between the tiles will be performed during scheduled boiler outages.

Because of its resistance to chemical attack and its ease of repair, the reliability of the tile and mortar system is expected to be superior to any other material for absorber construction, and lifecycle costs are expected to be substantially lower than those of either a steel alloy absorber or a carbon steel absorber lined with chlorobutyl rubber or flake glass. In addition to increased reliability and decreased maintenance, the expected life of the tile lining is three to four times that expected for rubber liners. Thus, the probability of successful operation of the scrubber is high.

The integration of two FGD absorber modules in a single vessel has not been commercially demonstrated. The primary risk associated with a split module design, as compared with two independent modules, concerns the integrity of the central wall that divides the module into independent halves and problems that could result from a high temperature gradient across this wall. With the split module design, there will always be flue gas flowing on one or both sides of the central wall. Repairs to this wall, such as sealing leaks and repointing, will be performed while there is hot gas on the opposite side. The proposed project will demonstrate the success of the repair method and prove the reliability of the split module design and the ability of the central wall to act successfully as a barrier between a hot operating module and a cool shutdown module.

The concept of constructing an absorber module below the flues has not been demonstrated in the U.S., although this concept has been demonstrated in Austria. The proposed demonstration project differs from the Austrian unit in several significant areas. The MCCTD project will use multiple stack flues, a rectangular absorber base, a wet stack, and up to 4% sulfur coal and has a total capacity of 300 MWe. The Austrian unit has a single flue, a circular absorber base, flue gas reheat, burns low-sulfur coal, and has a total capacity of 220 MWe. However, none of these differences is expected to result in significant design or operational problems.

A potential problem is the accumulation on the inner surface of the stack flue of significant amounts of solids, which could break off and fall back into the absorber module and cause damage to its internals. The degree of buildup will be a function of process chemistry, process design, and mist eliminator performance. If solids buildup is a problem, it should appear during the demonstration run. However, with the advanced FGD process design provided by S-H-U, mist carryover should be low enough so that significant flue liner solids buildup will not occur.

Based on successful operating data from NO_xOUT\ applications and on 25 test demonstrations that include NO_x concentrations of up to 650 ppm, the technical risk of not achieving 30% NO_x removal is very small. A continuous NO_x monitor will be provided to measure the level of NO_x removed in the flue gas, and manual testing of the fly ash will verify a maximum ammonia slip of 2 ppm to ensure that fly ash sales are not affected.

Failure of the high efficiency air heater system could result in plant shutdown or low load operation. Factors which may cause high efficiency air heater system unavailability include:

o Corrosion of tubes or plates due to SO_3 condensation.

- o Inability to achieve design heat transfer rates due to unanticipated fouling and/or inability to clean the heat transfer surfaces.

- o Inability to handle the required throughput of flue gas due to plugging with resultant high pressure drop across the unit.

These risk factors will be addressed in the design of the air heater by considering corrosion resistant tubes or plates, by using conservative fouling factors in the design, and by providing for adequate soot blowing. These risks are mitigated by installing the high efficiency air heater system on only one of Milliken's two units and by utilizing the CAPSIS corrosion monitoring system.

The approach of providing a feed-back control signal from corrosion monitoring sensors in the flue gas stream to adjust the high efficiency air heater bypass damper setting is feasible, based on previous work on behalf of EPRI in the U.S. and CEGB/PowerGen in Europe.

In summary, the technical risks associated with this project are small and acceptable.

3.3.1.1 Similarity of the Project to Other Demonstration/Commercial Efforts

This project comprises a unique combination of retrofit technologies and plant modifications designed to achieve Clean Air Act Amendment emission levels while maintaining plant efficiency. Although all the technologies have been used in similar situations, the particular combination proposed for this project while feeding high-sulfur coal has not been demonstrated.

There have been approximately 30 installations of the S-H-U FGD process in Europe and Asia, serving over 8,000 MWe of plant capacity. This project will be the first demonstration in the U.S. It will also be the first U.S. demonstration of the split-flow, Stebbins' tile-lined absorber, installed below a flue.

The NO_xOUT\ technology is installed, or in the planning stage, on approximately 30 boilers ranging in size up to 900 million Btu/hr. However, none of these installations is firing high-sulfur coal. Thus, this project will be the first commercial demonstration of the NO_xOUT\ technology on a furnace firing U.S. high-sulfur bituminous coal.

Over 100 heat pipe air heaters have been installed on industrial and utility boilers. The most relevant utility installation is at West Penn Power's Pleasant Station at Willow Island, WV. The unit at Pleasant Station is about half the size of the unit proposed for this project. In addition, the unit that would be used in this project would incorporate features, such as corrosion feedback protection and replaceable tubes, included at EPRI's demonstration unit at Kintigh Station but not included at Pleasant Station. This project may be the first commercial-scale demonstration of some of these features. A heat plate air heater system has not been demonstrated in the U.S. If this option is selected, this project will be the first commercial demonstration of this technology in the U.S.

This project will be the first commercial-scale demonstration of this particular combination of air emissions reduction and energy improvement technologies and modifications.

3.3.1.2 Technical Feasibility

The S-H-U FGD process is fully commercial, with approximately 30 installations. The NO_xOUT\ process is also fully commercial with approximately 30 installations on industrial and utility boilers, although not on high-sulfur coals. There are over 100 commercial installations of heat pipe air heaters. Heat plate air heaters have been used, but not to any extent on coal-fired utility boilers.

In summary, all the pieces of this project are technically feasible, and the probability of successfully integrating them to achieve anticipated CAAA emission levels, while maintaining station efficiency, is high.

3.3.1.3 Resource Availability

Adequate resources are available for this project over the 69-month demonstration period. NYSEG has committed funds, as discussed in Section 6.1, adequate to cover the proposed project cost. They have also dedicated the necessary personnel to conduct this demonstration program.

Sufficient space is available at the Milliken Station site for installation of the new equipment required for the demonstration.

NYSEG has made arrangements to supply coal and limestone in the necessary quantities. Other resources, such as electricity and water, can be supplied in the required quantities by the existing systems.

3.3.2 Relationships Between Project Size and Projected Scale of Commercial Facility

As already discussed, the test boilers are 150 MWe pulverized-coal-fired utility units which will fire high-sulfur coal during the demonstration. These units are typical of a significant portion of the nation's electric utility operating base. Thus, there is the potential for wide application of the demonstrated technology after successful completion of this project.

3.3.3 Role of the Project in Achieving Commercial Feasibility of the Technology

This project will demonstrate, at commercial scale, novel technologies for meeting anticipated CAAA limits for SO_2 and NO_x levels on existing coal-fired units. The technology can use virtually any coal and can be retrofitted to many types of coal-fired furnaces. Success of the demonstration project will provide a great impetus to commercialization.

3.3.3.1 Applicability of the Data to be Generated

The demonstration project will test all aspects of the technology at commercial scale on a commercial coal-fired unit. Data collection, analysis, and reporting will be performed during the operations phase and will include on-stream factors, material balances, equipment performance, efficiencies, and SO_2 and NO_x emission levels. The data that will be generated will be directly applicable to other applications and will provide valuable information to permit commercialization.

3.3.3.2 Identification of Features that Increase the Potential for Commercialization

The 1990 CAAA requires existing coal-burning power plants to reduce SO_2 and NO_x emissions. Considering the technology options which are commercially available today, it appears that existing plants will have to rely heavily on wet FGD and NO_x mitigation upgrades to reach the levels of sulfur and NO_x removal expected in the legislation.

This project will demonstrate the commercial readiness and the technical and economic advantages of the MCCTD. If the demonstration is successful, the utility industry will be provided with a proven integrated technology for the economic control of air emissions.

The key features of the S-H-U FGD technology which make it marketable are its competitive capital and operating costs, consistently high SO_2 removal (95-98%) over wide load ranges; its efficient limestone utilization; its ease of operation during plant transients; its consistently high-quality gypsum by-product; its low energy requirements; and its excellent reliability and low maintenance cost. The formic acid buffering permits operations within a pH range that precludes the formation of sulfite scale, often a problem in competing wet FGD systems. The buffering also has another significant advantage in that it permits high SO_2 removals at lower liquid to gas ratios. S-H-U absorbers may be used effectively on a wide range of boiler sizes.

The S-H-U process is particularly well suited for the treatment of flue gas from burning high-chloride coals, because of the buffering effect of the formic acid additive. No prescrubber is required, and the process can operate with more than 50,000 ppm chloride in the recycle slurry without a detrimental effect on performance. Chlorides absorbed from the flue gas exit the system as calcium chloride dissolved in the scrubber blowdown stream. The calcium chloride can be recovered and sold as a by-product for road deicing, use as a desiccant, etc.

Stebbins ceramic tile is abrasion, corrosion, and thermal shock resistant, is durable and provides exceptional strength. The tile system is amenable to a broad range of FGD chemical environments and is not limited to the S-H-U process. Ceramic tile is corrosion resistant throughout the entire range of FGD operating conditions (temperature, pH, chloride concentration, and organic acid additives).

The advantages of Stebbins ceramic tile construction include on-line repair, a reduction in maintenance costs, and increased reliability. The split module absorber cannot be constructed with rubber-lined, flake glass-lined, or alloy-clad vessels. The ability to provide individual modules at a relatively low cost is a very marketable concept. The most marketable aspect of the tile itself should be its expected lower life cycle costs compared with other construction materials. The life cycle costs associated with the use of a tile and mortar lining system are expected to be substantially lower than those of either steel alloy or rubber linings. In addition to increased reliability and decreased maintenance, the expected life of the tile lining is three to four times that expected for rubber liners. The combination of durability and reliability will enable Stebbins to effectively market this product to FGD vendors and utilities.

The key features of the high efficiency air heater system which make it marketable are the improvement in boiler thermal efficiency over a regenerative air heater; no leakage from air side to flue gas side; potential for increased heat transfer, reduced exit gas temperature, and increased boiler efficiency due to the CAPCIS corrosion monitoring system; and easily replaceable modules. The demonstration of these features will encourage the widespread commercialization of high efficiency air heater systems.

The key features of the NO_xOUT\ technology which make it marketable are the consistent rate of NO_x removal with a very low ammonia slip. Low ammonia slip eliminates air heater plugging. Due to the low ammonia slip, the sale and use of the fly ash as a pozzolanic material in the formation of concrete will not be affected. Also, the addition of proprietary chemicals has increased the temperature range in which the NO_x removal reaction is effective, thus allowing the NO_xOUT\ reagent to be injected at various elevations in the boiler. Injecting reagent at different elevations allows the NO_x to be removed in stages. This staged approach allows high NO_x removal efficiencies with very low ammonia slip. NO_xOUT\ technology can be used very effectively on a wide range of boiler sizes and configurations.

3.3.3.3 Comparative Merits of the Project and Projection of Future Commercial Economics and Market Acceptability

The MCCTD project will demonstrate a combination of technologies, including the S-H-U process for SO_2 reduction, NO_xOUT\ technology for NO_x reduction, and a high efficiency air heater system for efficiency improvement. These technologies are suitable for either retrofit on existing boilers or incorporation into new construction. They are also suitable for a wide variety of boiler types, ages, sizes, fuel types, and fuel sulfur levels.

This technology should permit furnaces to meet CAAA air emission levels at competitive costs; and features, such as little or no loss in efficiency, production of marketable by-products, and no wastewater discharge, should make the technology attractive to the commercial market from an environmental and economic point of view.

Emissions of nitrogen oxides from coal-fired boilers have typically been controlled through combustion modification technology. This technology will not ensure that the mandated reductions are achieved. This is evident in the regulatory exception provided in the CAAA for those units in which combustion technology fails to meet the emission limits. While the first phase of the CAAA will allow continuation of this practice, stricter guidelines set forth in 1997 will require emission reductions to be based on the best available technology, taking into account the costs, energy, and environmental impacts. Therefore, control technologies which can demonstrate compliance with emission goals on a cost effective basis will be commercially sought after.

4.0 ENVIRONMENTAL CONSIDERATIONS

The NEPA compliance procedure, cited in Section 2.2, contains three major elements: a Programmatic Environmental Impact Statement (PEIS); a preselection, project-specific environmental analysis; and a post-selection, site-specific environmental analysis. DOE issued the final PEIS to the public in November 1989 (DOE/EIS-0146). In the PEIS, results derived from the Regional Emissions Database and Evaluation System (REDES) were used to estimate the environmental impacts expected to occur in 2010 if each technology were to reach full commercialization and capture 100% of its applicable market. These impacts were compared with the no-action alternative, which assumed continued use of conventional coal technologies through 2010 with new plants using conventional flue gas desulfurization to meet New Source Performance Standards.

The preselection, project-specific environmental review, focusing on environmental issues pertinent to decisionmaking, was completed for internal DOE use. This review summarized the strengths and weaknesses of each proposal in compliance with the environmental evaluation criteria in the PON. It included, to the extent possible, a discussion of alternative sites and processes reasonably available to the offeror, practical mitigating measures, and a list of required permits. This analysis was provided for the consideration of the Source Selection Official in the selection of proposals.

As the final element of the NEPA strategy, the Participant (NYSEG) will submit to DOE the Environmental Information Volume specified in the PON. This detailed site- and project-specific information will form the basis for the NEPA documents prepared by DOE. These documents, prepared in compliance with the Council on Environmental Quality regulations for implementation of NEPA and the DOE regulations for NEPA compliance, must be approved before Federal funds can be provided for detailed design, construction, and operation activities.

In addition to the NEPA requirements outlined above, the Participant must prepare and submit an Environmental Monitoring Plan (EMP) for the project. The purpose of the EMP is to ensure that sufficient technology, project, and site environmental data are collected to provide health, safety, and environmental information for use in subsequent commercial applications of the technology.

Current uncontrolled SO_2 emissions from Milliken Station average approximately 30,000 tons of SO_2 released to the atmosphere each year. With the proposed flue gas desulfurization system, SO_2 emissions will be reduced to about 3,170 tons/yr. Milliken currently emits about 6,100 tons of NO_x emissions per year. As a result of this project, NO_x emissions should drop from approximately 0.56 lb/million Btu to 0.45 lb/million Btu, thereby reducing yearly emissions to about 4,900 tons/yr.

Plans for the project include construction of a 374-foot chimney through which flue gas will be discharged. Results of dispersion modeling for the new chimney indicate that, with the planned improvements, Milliken Station will easily meet all ambient air quality standards.

The FGD system will generate four types of solids, three of which have the potential to be usable by-products: (1) gypsum, (2) calcium chloride, (3) limestone storage area runoff sediment, and (4) FGD blowdown treatment sludge. The only nonreusable solid by-product is metal hydroxide suspended solids removed from FGD blowdown water after chemical treatment. Treatment of FGD system blowdown is estimated to increase the metal hydroxide sludge quantity now generated at Milliken Station by 54%. The existing coal pile runoff/maintenance cleaning waste treatment system currently produces approximately 500 tons of metal hydroxide sludge per year. FGD blowdown treatment will produce an additional 270 tons of dewatered sludge per year. FGD system sludge will be disposed of in the same manner as existing water treatment sludge, which is either sent to a Blossburg, Pennsylvania, coal mine that is being reclaimed or is disposed of at the Milliken landfill. All FGD system liquid streams are collected and treated to produce water suitable for reuse.

No problems are anticipated in obtaining any of the necessary permits for this project.

5.0 PROJECT MANAGEMENT

5.1 Overview of Management Organization

The project will be managed by a NYSEG Project Manager. This individual will be the principal contact with DOE for matters regarding the administration of the Cooperative Agreement between NYSEG and DOE. The DOE Contracting Officer is responsible for all contract matters, and the DOE Contracting Officer's Technical Project Officer (TPO) is responsible for technical liaison and monitoring of the project.

5.2 Identification of Respective Roles and Responsibilities

DOE

DOE shall be responsible for monitoring all aspects of the project and for granting or denying approvals required by the Cooperative Agreement. The DOE Contracting Officer is DOE's authorized representative for all matters related to the Cooperative Agreement.

The DOE Contracting Officer will appoint a TPO who will be the authorized representative for all technical matters and will have the authority to issue "Technical Advice" which may:

- Suggest redirection of the Cooperative Agreement effort, recommend a shifting of work emphasis between work areas or tasks, or suggest pursuit of certain lines of inquiry which assist in accomplishing the Statement of Work.

- Approve all technical reports, plans, and items of technical information required to be delivered by the Participant to the DOE under the Cooperative Agreement.

The DOE TPO does not have the authority to issue technical advice which:

- Constitutes an assignment of additional work outside the Statement of Work.

- In any manner causes an increase or decrease in the total estimated cost or the time required for performance of the Cooperative Agreement.

- Changes any of the terms, conditions, or specifications of the Cooperative Agreement.

- Interferes with the Participant's right to perform the terms and conditions of the Cooperative Agreement.

All technical advice shall be issued in writing by the DOE TPO.

Participant

The following organizations will interact effectively to meet the intent of the PON and to assure a timely and cost-effective implementation of the MCCTD project from conceptual design to start-up and operation:

- *New York State Electric & Gas Corporation*
- Saarberg-Hölter Unwelttechnik, Gmbh
- Stebbins Engineering and Manufacturing Company (Stebbins)
- Consolidation Coal Company (CONSOL Inc.)
- NALCO Fuel Tech

NYSEG will be primarily responsible for reporting to and interfacing with DOE. NYSEG will be responsible for all phases of the project.

The overall project approach of the above Participants will include, but not necessarily be limited to:

- A single project manager will be responsible to DOE and all project Participants for all three project phases.

- NYSEG will be the primary liaison between the Government and all other organizations, as shown in Figure 8, Project Organization.

- The Generation Department of NYSEG's Electric Business Unit will manage the MCCTD project. NYSEG's construction management organization will be responsible for the overall construction and construction management activities of the project. This will include the organization, planning, management, direction, and supervision of all labor and contractor operations. NYSEG will also be responsible for material and equipment receipt and inspection, equipment and material storage, temporary construction facilities and services, erection of all equipment and material, and the field activities of the major subcontractors during the construction period. The architect/engineering firm of Gilbert Commonwealth (G/C) has been selected through competitive bidding to supplement NYSEG administrative, engineering and construction management efforts. NYSEG, with the aid of G/C, will develop the detailed design for the FGD system, as well as for the balance of the plant systems. The NYSEG-G/C team will develop specifications and procure all equipment components directly from the original equipment manufacturers. They will develop the control system design based on operational requirements supplied by S-H-U. Responsibility for receipt and installation of all components will be assigned to qualified specialty contractors. The NYSEG-G/C team will provide construction management for all contract packages. NYSEG normally performs major projects in this manner and has developed organizational procedures to effectively plan, organize, and control the work.

- S-H-U's main function will be to supply process design and operational requirements for the gas treatment, reagent preparation, and solids dewatering systems. S-H-U will act in an advisory role to review the detailed design and equipment selection to protect the basic FGD system performance guarantees. They will also provide construction and start-up advisory services for the FGD system and training for the NYSEG operators.

- Stebbins' main function will be to provide the design for and construct the tile-lined FGD absorber.

- NALCO Fuel Tech's main function will be to provide the design for the NO_xOUT\ technology and to provide start-up support.

- CONSOL's main function will be to act as a consultant during this project.

5.3 Project Implementation and Control Procedures

All work to be performed under the Cooperative Agreement is divided into three phases. These phases are:

Phase I: Design and Engineering (6 months)
Phase II: Construction (27 months)
Phase III: Operations (36 months)

As shown in Figure 9, the total project encompasses 69 months.

Two budget periods will be established. Consistent with P.L. 101-512, DOE will obligate funds sufficient to cover its share of the cost for each budget period. Throughout the course of this project, reports dealing with the technical, management, cost, and environmental monitoring aspects of the project will be prepared by NYSEG and provided to DOE.

5.4 Key Agreements Impacting Data Rights, Patent Waivers, and Information Reporting

The key agreements in respect to patents and data are:

- Standard data provisions are included, giving the Government the right to have delivered and use, with unlimited rights, all technical data first produced in the performance of the Agreement.

- Proprietary data, with certain exclusions, may be required to be delivered to the Government. The Government has obtained rights to proprietary data and non-proprietary data sufficient to allow the Government to complete the project if the Participant withdraws.

- Rights in background patents and background data of NYSEG and all of its subcontractors are included to assure commercialization of the technology.

NYSEG will make such data, as is applicable and non-proprietary, available to the U.S. DOE, U.S. EPA, other interested agencies, and the public.

5.5 Procedures for Commercialization of the Technology

In developing this project, NYSEG went through a selection process to choose a project team that best satisfied the DOE's Clean Coal Technology Demonstration Project objectives and NYSEG's perception of utility industry needs. A utility sponsored project allows for demonstration of technologies that are integrated, comprehensive, and of practical use to plant operations. The attributes of the demonstration were selected to facilitate industry acceptance of the technology.

Included in the project team are technology vendors that plan to aggressively market their technologies, consistent with the proposed cooperative agreement. Research organizations, including EPRI, ESEERCO, and NYSERDA, will provide an unbiased assessment and technology transfer to their members. Structuring the project in this manner results in several commercialization plans with more than one vendor responsible for commercialization. In the FGD area, the FGD process vendor, S-H-U, and the absorber vessel supplier, Stebbins, will each commercialize their individual technology. Nalco Fuel Tech will commercialize the NO_x reduction technology. A vendor will be selected to commercialize the high energy air heater system technology.

Although NYSEG does not expect to have any financial interest in the commercialization of the technologies, it has required that each technology vendor have a commercialization plan that meets the requirements of the cooperative agreement. NYSEG is committed to the success of these commercialization efforts and will allow use of the demonstration facility in each of the technology vendor's business plans. NYSEG is also committed to an unbiased assessment of the demonstrated technologies and to communicating the results throughout the industry.

6.0 PROJECT COST AND EVENT SCHEDULING

6.1 Project Baseline Costs

The total estimated cost for this project is $158,607,807. The Participant's share and the Government's share in the costs of this project are as follows:

	Dollar Share ($)	Percent Share (%)
Pre-Award		
Government	60,261	28.37
Participant	152,136	71.63
Phase I		
Government	5,543,716	49.90
Participant	5,565,935	50.10
Phase II		
Government	37,896,023	32.04
Participant	80,368,217	67.96
Phase III		
Government	1,500,000	5.17
Participant	27,521,519	94.83
Total Project		
Government	45,000,000	28.37
Participant	113,607,807	71.63

The project will be co-funded by DOE and NYSEG.

DOE	$ 45,000,000
NYSEG	$113,607,807
TOTAL	$158,607,807

At the beginning of each budget period, DOE will obligate funds sufficient to pay its share of expenses for that budget period.

6.2 Milestone Schedule

The overall project will be completed in 69 months. The project schedule, by phase and activity, is shown in Figure 9.

Phase I, which involves design and engineering, will continue for 6 months. Phase II, construction, will last a total of 27 months. Phase III, operations, will last 36 months.

6.3 Repayment Plan

In response to DOE's stated policy to recover an amount up to the Government's contribution to the project, the Participant has agreed to repay the Government in accordance with the Repayment Agreement, which is consistent with the model repayment agreement in the CCT-IV PON.

FIGURE 1. MILLIKEN STATION CLEAN COAL DEMONSTRATION PROJECT LOCATION

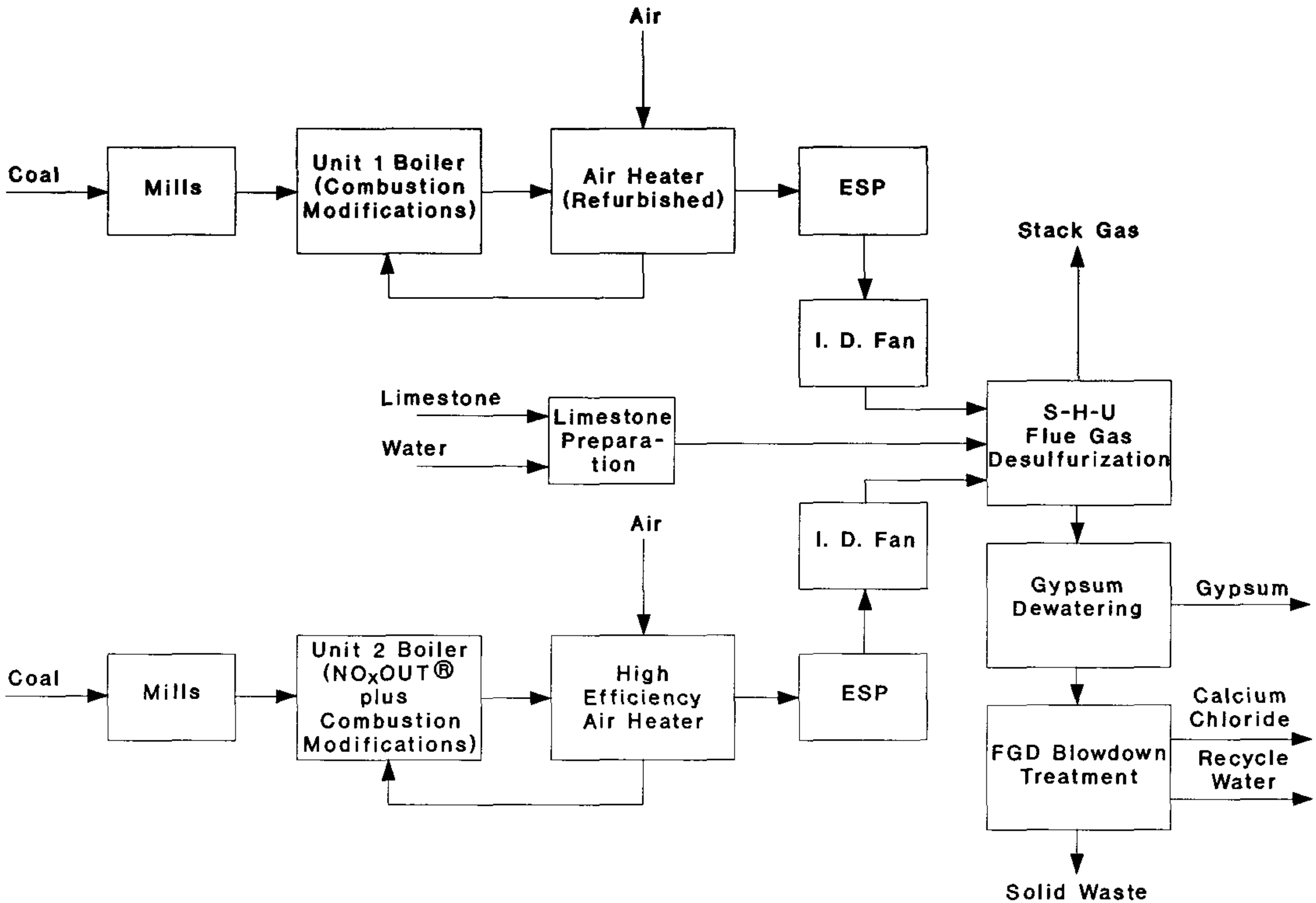

FIGURE 2. MILLIKEN STATION CLEAN COAL DEMONSTRATION PROJECT

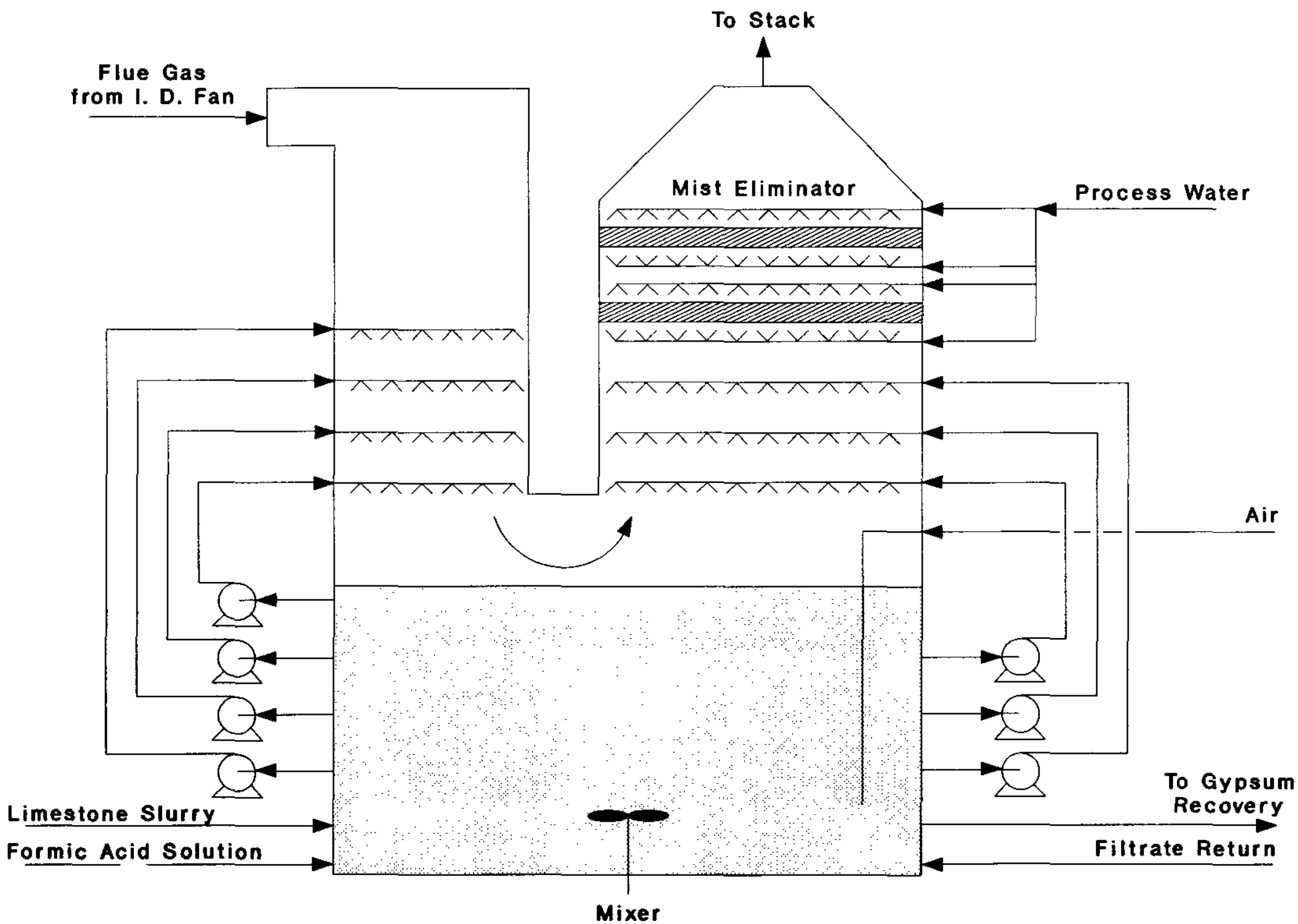

FIGURE 3. S-H-U FGD ABSORBER

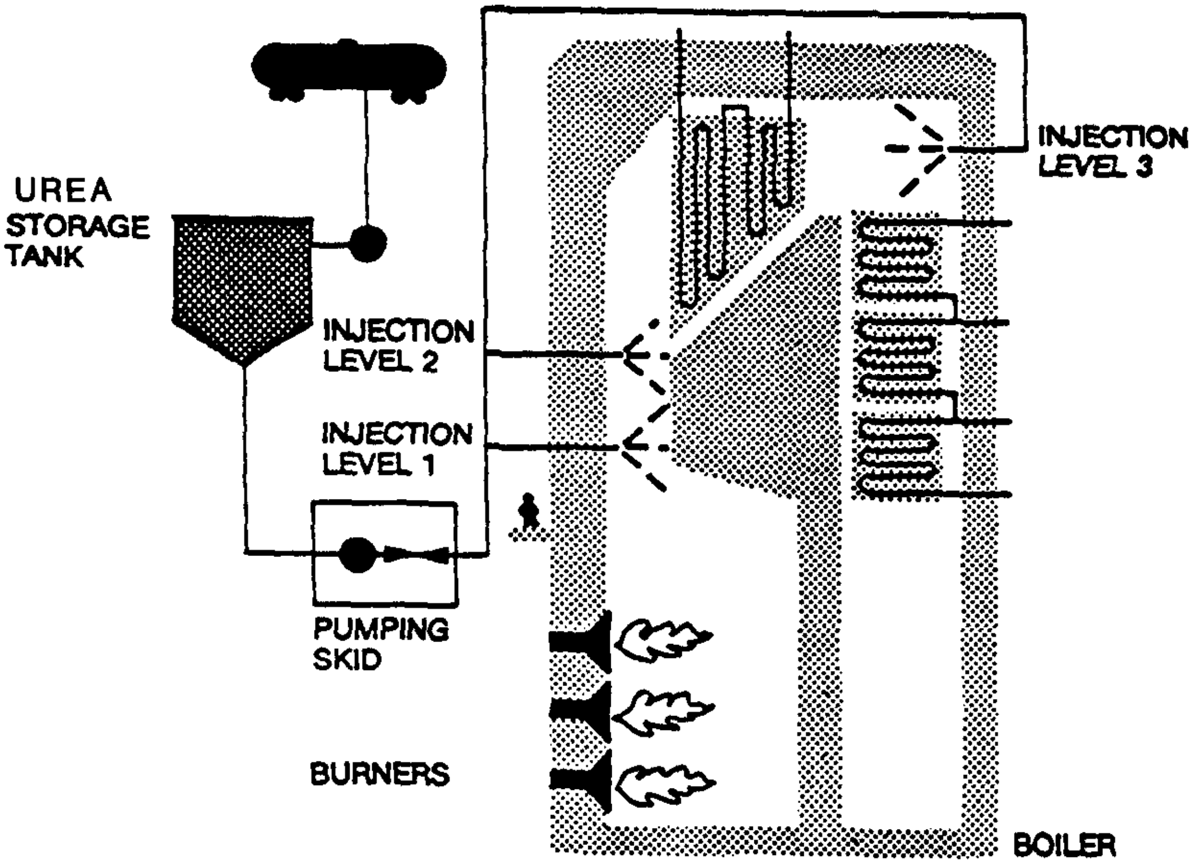

FIGURE 4. $NO_xOUT^{®}$ PROCESS

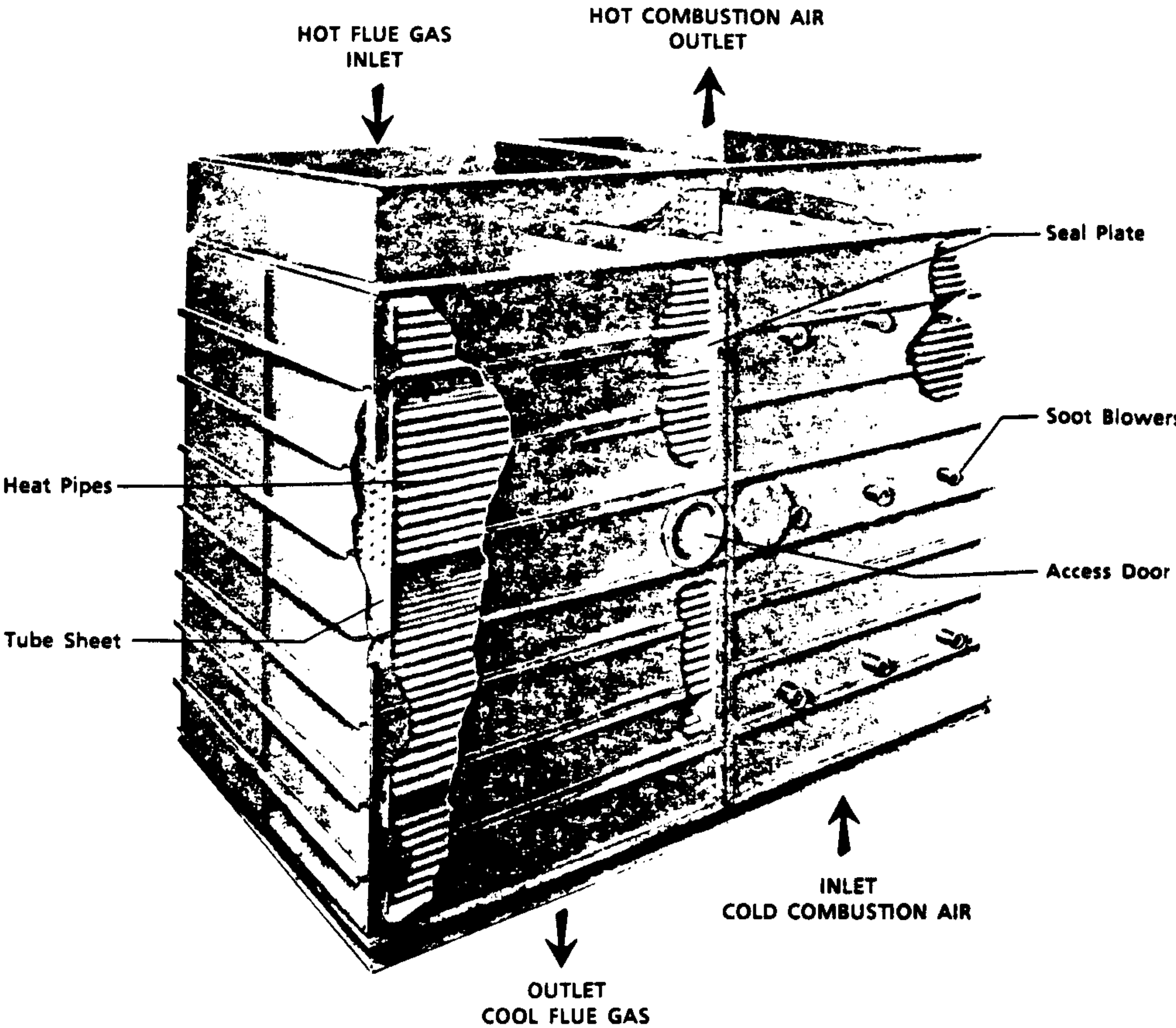

FIGURE 5. TYPICAL HEAT PIPE ASSEMBLY

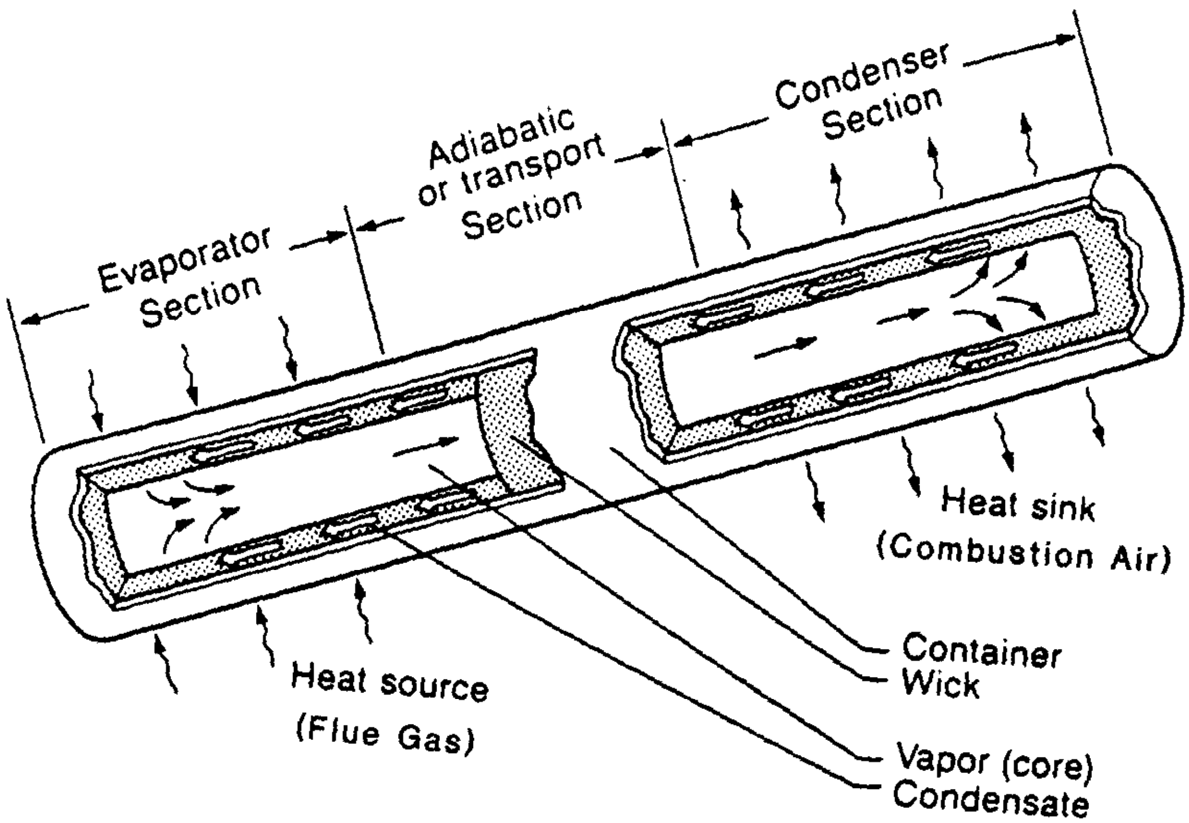

FIGURE 6. SCHEMATIC OF HEAT PIPE TUBE

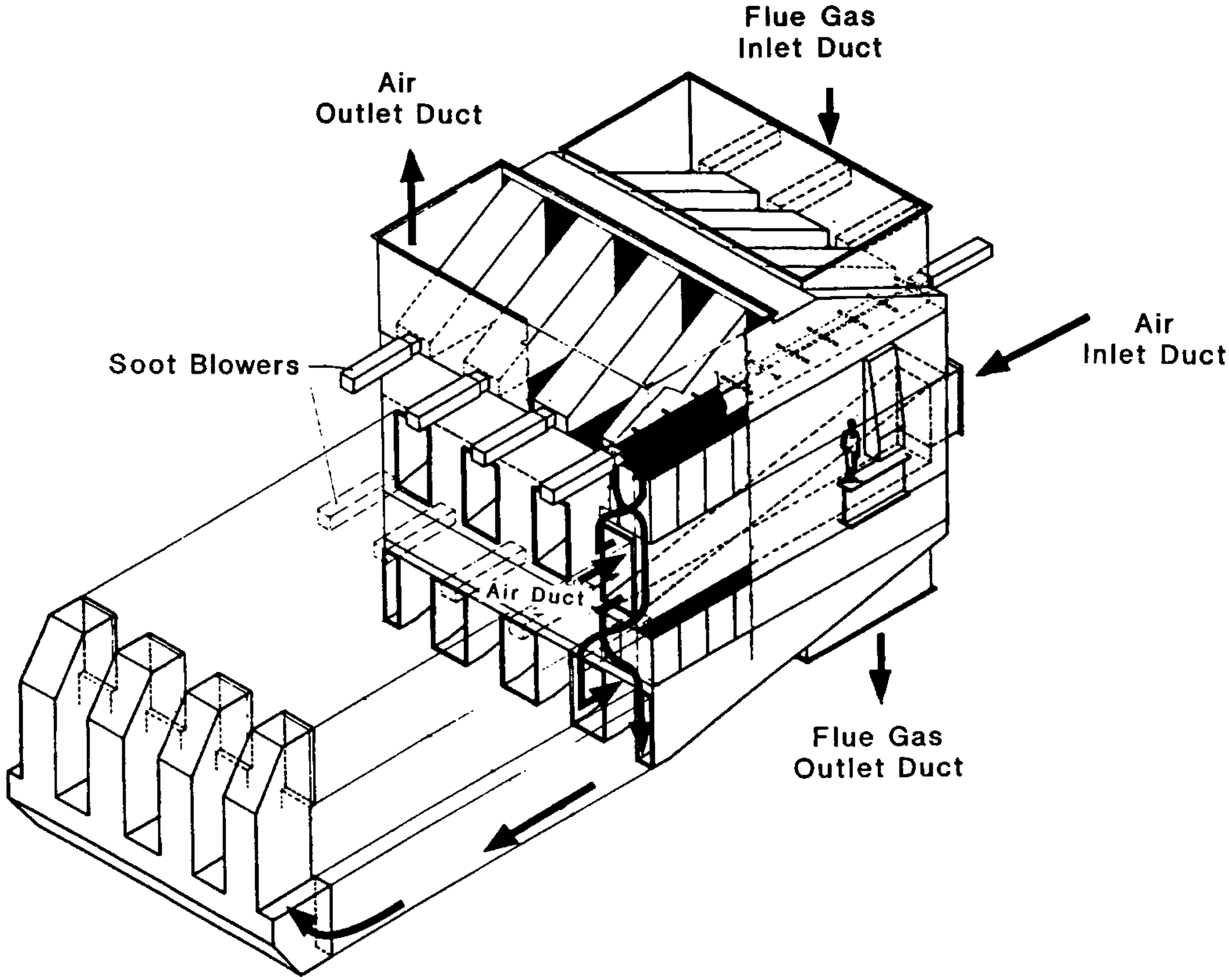

FIGURE 7. TYPICAL HEAT PLATE ASSEMBLY

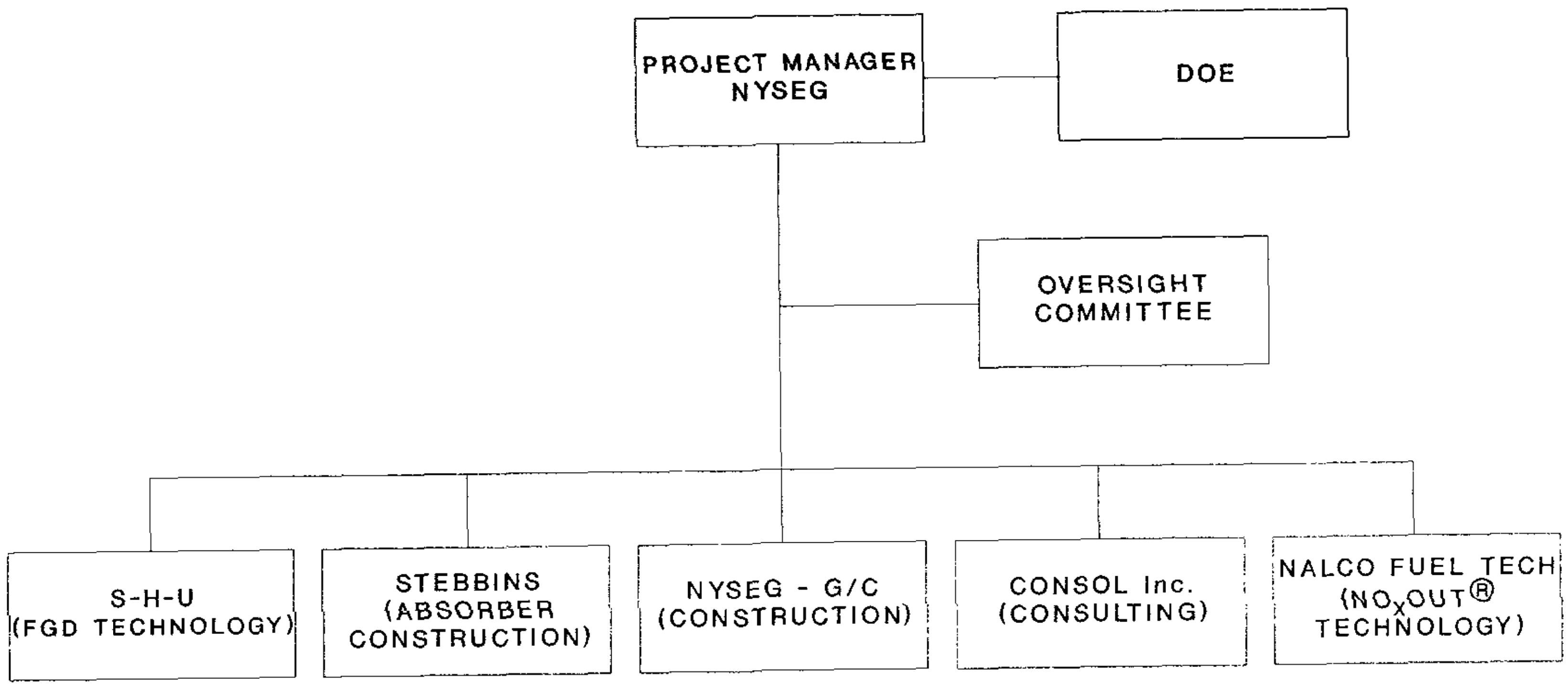

FIGURE 8. PROJECT ORGANIZATION FOR MCCTD PROJECT

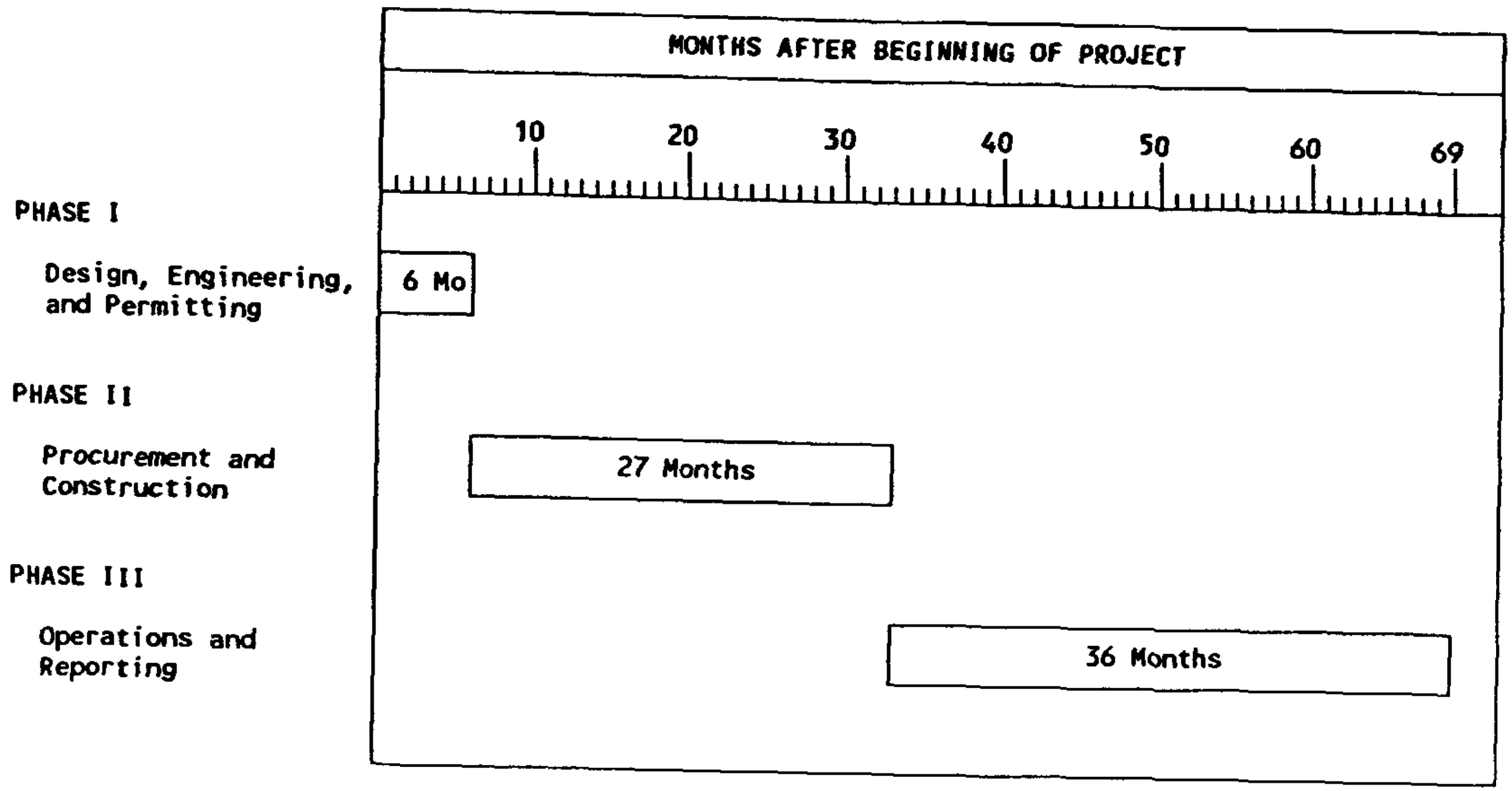

FIGURE 9. OVERALL SCHEDULE FOR MCCTD PROJECT