DOE/FE-0206P

Comprehensive Report to Congress
Clean Coal Technology Program

Blast Furnace Granulated Coal Injection System Demonstration Project

A Project Proposed By:
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U.S. Department of Energy
Assistant Secretary for Fossil Energy
Office of Clean Coal Technology
Washington, DC 20585

October 1990

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1.0 EXECUTIVE SUMMARY

In September 1988, Congress provided $575 million to conduct cost-shared Clean Coal Technology (CCT) projects to demonstrate technologies that are capable of retrofitting or repowering existing facilities. To that end, a Program Opportunity Notice (PON) was issued by the Department of Energy (DOE) in May 1989, soliciting proposals to demonstrate innovative energy-efficient technologies that were capable of being commercialized in the 1990s, and were capable of (1) achieving significant reductions in the emissions of sulfur dioxide and/or the oxides of nitrogen 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, 48 proposals were received in August 1989. After evaluation, 13 projects were selected in December 1989 as best furthering the goals and objectives of the PON. The projects were located in ten different states and represented a variety of technologies. A proposal by Bethlehem Steel Corporation was one of those selected for negotiation.

Bethlehem Steel Corporation (BSC), of Bethlehem, Pennsylvania, has requested financial assistance from DOE for the design, construction, and operation of a 2,800-ton-per-day blast furnace granulated coal injection (BFGCI) system for each of two existing iron-making blast furnaces. The blast furnaces to be retrofitted with BFGCI each have the capacity of 7,000 net tons of hot metal (NTHM) per day. The blast furnaces are located at BSC's facilities in Burns Harbor, Indiana. The demonstration project would last approximately 68 months at a total cost of $143,800,000. DOE's share of the project cost would be 21.7 percent, or $31,259,530.

BFGCI technology involves injecting coal directly into an iron-making blast furnace and subsequently reduces the need for coke on approximately a pound of coke for pound of coal basis. BFGCI also increases blast furnace production. Coke will be replaced with direct coal injection at a rate of up to 400 pounds per NTHM. The reducing environment of the blast furnace enables all of the sulfur in the coal to be captured by the slag and hot metal. The gases exiting the blast furnace are cleaned by cyclones and then wet scrubbing to remove particulates. The cleaned blast furnace gas is then used as a fuel in plant processes. There is no measurable sulfur in the off gas.

The primary environmental benefits derived from blast furnace coal injection result from the reduction of coke requirements for iron making. Reduced coke production will result in reduced releases of environmental contaminants from coking operations.

In addition to BSC, which will be the signatory to the Cooperative Agreement, will own and operate the demonstration facility, and will provide the site and blast furnaces, the project team will include ATSI, Inc. (ATSI) of Buffalo, New York, Simon Macawber, Ltd. (SM) of Doncaster, England, and British Steel Consultants Overseas Services, Inc. (BSCOS), a marketing arm of British Steel. The BFGCI technology to be demonstrated was developed by British Steel and SM. British Steel has granted exclusive rights to market BFGCI technology, worldwide, to SM. SM and ATSI have formed a joint venture to market BFGCI systems in the U.S. and Canada. SM also has the right to sublicense marketing rights to other organizations throughout the world. For the project, BSCOS will provide technology know-how and training, SM will supply some equipment (mainly a special injector nozzle design for granulated coal injection), and ATSI will provide some process design, construction engineering, and procurement services. ATSI, through the joint venture, will also commercialize the BFGCI technology in North America.

2.0 INTRODUCTION AND BACKGROUND

The domestic coal resources of the United States play an important role in meeting current and future energy needs. During the past 20 years, considerable effort has been directed to developing improved coal combustion, conversion, and utilization processes to provide efficient and economic energy options. These technology developments permit the efficient use of coal in a cost-effective and environmentally acceptable manner.

2.1 REQUIREMENT FOR A REPORT TO CONGRESS

On September 27, 1988, Congress made available funds for the third clean coal demonstration program (CCT-III) in Public Law 100-446, "An Act Making Appropriations for the Department of the Interior and Related Agencies for the Fiscal Year Ending September 30, 1989, 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 retrofitting or repowering existing facilities ...." On June 30, 1989, Public Law 101-45 was signed into law, requiring that CCT-III projects be selected no later than January 1, 1990.

Public Law 100-446 appropriated a total of $575 million for executing CCT-III. Of this total, $6.906 million are required to be reprogrammed for the Small Business and Innovative Research Program (SBIR) and $22.548 million are designated for Program Direction Funds for costs incurred by DOE in implementing the CCT-III program. The remaining, $545.546 million, was available for award under the PON.

The purpose of this Comprehensive Report is to comply with Public Law 100-446, which directs the Department to prepare a full and comprehensive report to Congress on each project selected for award under the CCT-III Program.

2.2 EVALUATION AND SELECTION PROCESS

DOE issued a draft PON for public comment on March 15, 1989, receiving a total of 26 responses from the public. The final PON was issued on May 1, 1989, and took into consideration the public comments on the draft PON. Notification of its availability was published by DOE in the Federal Register and the Commerce Business Daily on March 8, 1989. DOE received 48 proposals in response to the CCT-III solicitation by the deadline, August 29, 1989.

2.2.1 PON Objective

As stated in PON Section 1.2, the objective of the CCT-III solicitation was to obtain "proposals to conduct cost shared Clean Coal Technology projects to demonstrate innovative, energy efficient technologies that are capable of being commercialized in the 1990's. These technologies must be capable of

(1) achieving significant reductions in the emissions of sulfur dioxide and/or the oxides of nitrogen 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."

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) from mines located in the United States.

(c) The proposer must agree to provide a cost share of at least 50 percent of total allowable project cost, with at least 50 percent 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 7.4.

(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 objective of the PON, and must contain sufficient business and management, technical, cost, and other information 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) Demonstration Project Factors used to assess the technical feasibility and likelihood of success of the project, and (2) Commercialization Factors 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 Business and Management Criteria required a funding plan and an indication of financial commitment. These 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 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 the oxides of nitrogen.

(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 transboundary pollution, and (2) providing for future energy needs by the environmentally acceptable use of coal or coal-based fuels.

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 provided 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 receive identical evaluation scores and remain essentially equal in value. This consideration would not be applied if, in doing so, the regional geographic distribution of the projects selected would be altered significantly.

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 (NEPA) of 1969, the Council on Environmental Quality regulations for implementing NEPA regulations (40 CFR 1500-1508), and the DOE guidelines for compliance with NEPA (52 FR 47662, December 15, 1987).

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 13 projects as best furthering the objectives of the CCT-III PON.

Secretary of Energy, Admiral James D. Watkins, U.S. Navy (Retired), announced the selection of 13 projects on December 21, 1989. In his press briefing, the Secretary stated he had recently signed a DOE directive setting a 12-month deadline for the negotiation and approval of the 13 cooperative agreements to be awarded under the CCT-III solicitation.

3.0 TECHNICAL FEATURES

3.1 PROJECT DESCRIPTION

BSC proposes to retrofit two high-capacity blast furnaces with BFGCI systems (Figure 1). These large, modern blast furnaces are Units "C" and "D" at BSC's steel plant in Burns Harbor, Porter County, Indiana, located on the southeast shore of Lake Michigan (Figure 2). The two blast furnaces operate around the clock, and each has a production capacity of 7,000 net tons of hot metal (NTHM) per day.

In addition to displacing injected natural gas, the coal injected through the blast furnace tuyeres will displace coke, the primary blast furnace fuel and reductant, on approximately a pound for pound basis. Depending on the amount of coal fed, the coke requirement will be reduced by up to 40 percent, resulting in net improvements to the environment. Sulfur in the coal will be captured in the by-product slag. The slag can be reclaimed and used for a variety of products, including high-quality cement and roadbed aggregate.

The Burns Harbor project will be operated to generate data which will be applicable to the entire domestic integrated steel industry. The project will demonstrate sustained operation with a variety of coal particle sizes, coal

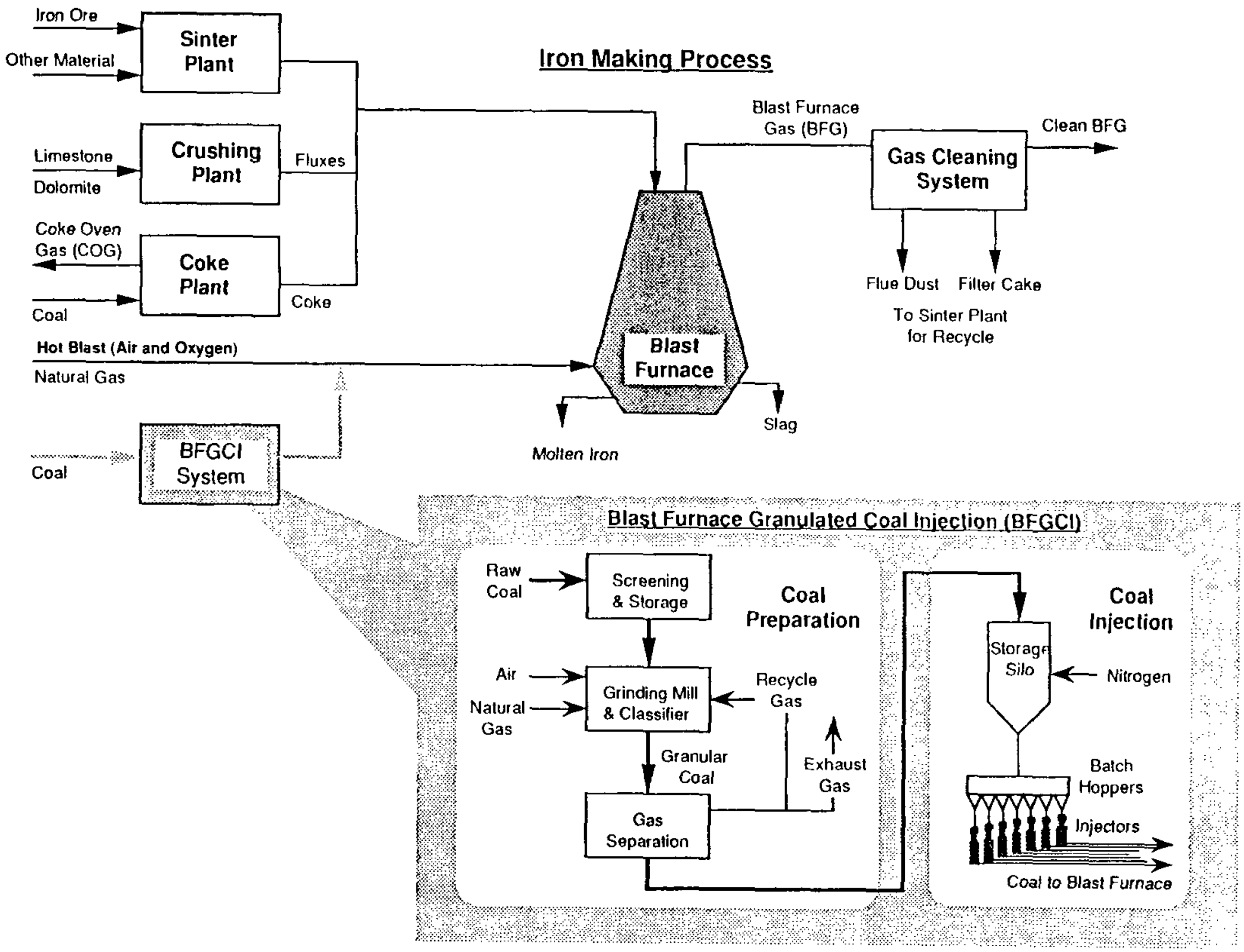

Figure 1. Blast Furnace Granulated Coal Injection For Iron Making

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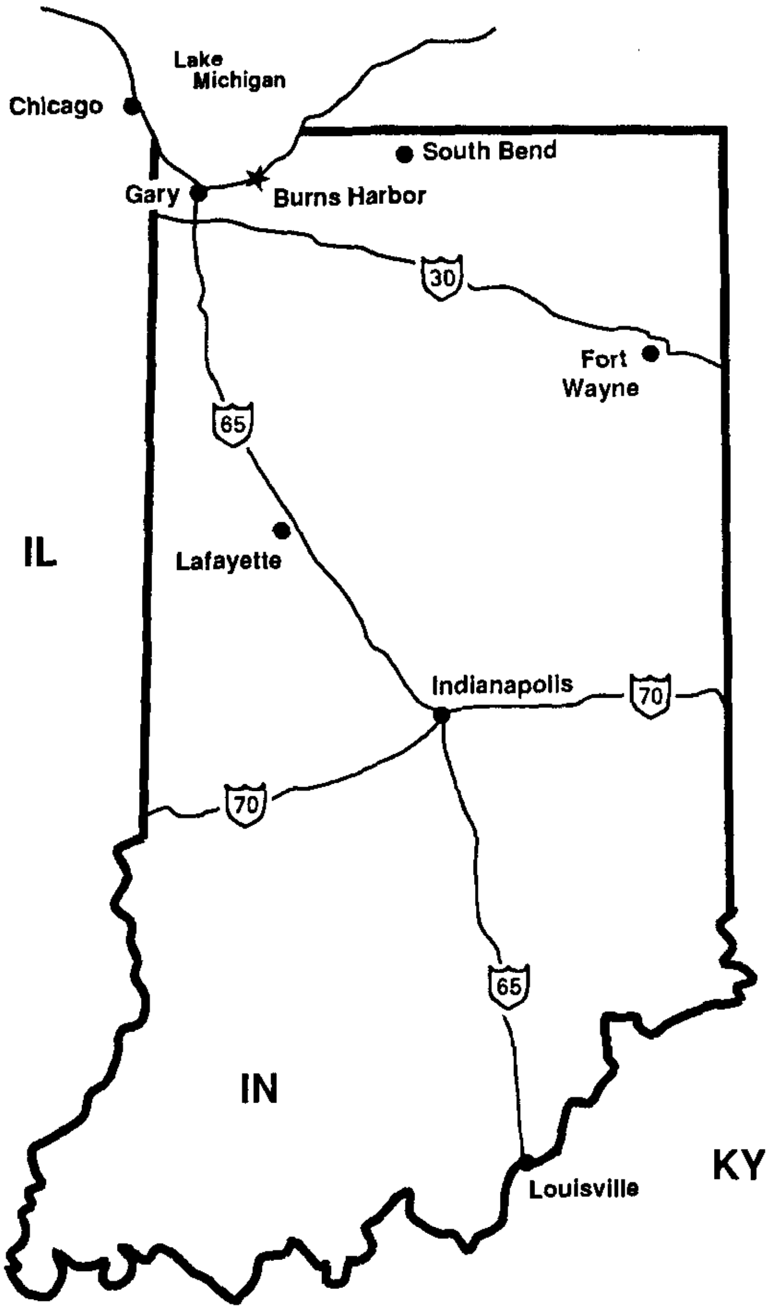

Figure 2. Bethlehem Steel BFGCI Project

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injection rates, and coal types and will assess the interactive nature of these parameters. In addition, two different methods of blast furnace conversion will be demonstrated. Technical features of the project follow.

Coal Particle Size

Operation of the BFGCI system will be demonstrated on a broad range of coal sizes spanning both fine (pulverized) and coarser (granulated) particles. However, the primary focus of the project will be on the coarser feed sizes, where potential advantages include reduced capital cost for grinding facilities and reduced energy consumption for the grinding process. The project will show the effects of coal particle size on blast furnace performance. Results will be of value in the planning of future domestic commercial installations, since there is no U.S. facility using coarse coal injection and only one (Armco Ashland) using fine coal, but in a substantially smaller furnace.

Coal Injection Rate

The plan for this project includes demonstrating and evaluating sustained operation of the BFGCI technology over a range of coal injection rates. One important objective is to reach a target rate of 400 lbs of coal per NTHM; a rate some 40 to 60 percent greater than that currently being used anywhere in the world. The present maximum sustained injection rates commercially utilized are 280 lbs per NTHM for pulverized coal and 250 lbs per NTHM for granulated coal.

Coal Source

This project will generate comparative data on coals from four separate mines that provide coal with distinctly different chemical and physical characteristics. The plan includes using an Eastern bituminous coal with low ash and sulfur content; an Eastern bituminous coal with moderate ash and higher sulfur content; a Midwestern bituminous coal with higher inherent moisture but with low ash and moderate-to-high sulfur content; and a Western subbituminous coal with high inherent moisture but with low ash and sulfur content.

Blast Furnace Conversion Method

The two blast furnaces will be converted to coal injection during 1994 and 1995. One furnace will be converted while it is out of service for relining of the furnace walls. Coal injection conversion for the other furnace will be made "on-the-fly" during very brief, perhaps 8-hour, outages. These conversions will demonstrate the successful implementation of coal injection for a blast furnace during both out-of-service and in-service modes.

3.1.1 Project Summary

Title:	Blast Furnace Granulated Coal Injection Project
Proposer:	Bethlehem Steel Corporation
Team Members:	Bethlehem Steel Corporation; ATSI, Inc.; Simon Macawber Ltd.; and British Steel Consultants Overseas Services, Inc.
Location:	Burns Harbor, Porter County, Indiana.
Technology:	Blast furnace granulated coal injection technology owned by British Steel plc.
Application:	Direct injection of granulated coal into an iron-making blast furnace, replacing coke on approximately a pound of coke for a pound of coal basis.
Type of Coal:	Eastern bituminous (low sulfur, low ash); Eastern bituminous (moderate ash and higher sulfur content); Midwestern bituminous (with higher moisture content, low ash, and moderate to high sulfur content); and Western subbituminous (with high inherent moisture, low ash, and low sulfur content).
Products:	Iron, saleable slag, and combustible process gas.
Project Size:	2,800 tons of coal per blast furnace per day (two blast furnaces).
Project Start:	January 1991
Project End:	September, 1996

3.1.2 Project Sponsorship and Cost

Project Sponsor:	Bethlehem Steel Corporation
Co-Funders:	Bethlehem Steel Corporation and U.S. Department of Energy
Estimated Project Cost:	$143,800,000
Cost Distribution:	Participant Share -- 78.3 percent DOE Share -- 21.7 percent

3.2 BLAST FURNACE GRANULATED COAL INJECTION PROCESS

3.2.1 Overview of Process Development

Fuel injection into blast furnace tuyeres dates back to 1840 with coal experiments in France. Trials in the United Kingdom in 1962 proved that the technology existed for pneumatic injection of granulated coal. The trials used coal with a size consist of 100 percent less than 1/8 inch (3.2 mm) and approximately 11 percent less than 74 micron. This size coal is easier and less expensive to produce, using a hammer mill, than is finer, pulverized coal with equipment such as ball or tube mill pulverizers. The trials also showed that the granulated coal would flow well using pneumatic conveying techniques. Injection rates of up to 360 pounds per NTHM were achieved using a wide variety of coals. The coal was found to reduce the need for coke on an equivalent weight basis. Coal injection was discontinued, however, because of lower oil prices.

The project proposed by BSC will use the BFGCI technology developed jointly by British Steel and SM. British Steel achieved injection rates of up to 110 pounds per NTHM with a pilot development system on the Queen Mary furnace at their Scunthorpe Works in 1983. In 1985 full-scale injection of granulated coal was demonstrated on both the Queen Victoria and Queen Anne furnaces at Scunthorpe, with injection rates exceeding 200 pounds per NTHM.

Currently, British Steel is operating BFGCI systems at both its Scunthorpe and Ravenscraig Works. The Scunthorpe facility has operated to date with over 1,000,000 tons of injected granulated coal. Since January 1989, rates of injection at Scunthorpe have been 250 pounds per NTHM.

3.2.2 Process Description

The principal purpose of a blast furnace is to smelt iron ores to produce pig iron. Other raw materials consumed in the smelting process are (1) coke, which is the principal fuel and reducing agent; (2) limestone and dolomite, which act to flux the earthy constituents in the iron-bearing materials and coke ash to form a slag; and (3) hot air and oxygen, which are needed to support combustion of the coke. Supplemental fuels such as heavy oils, tar, and natural gas have been used to replace some of the coke. Residence time for the solid materials in the blast furnace is typically 8 hours.

The blast furnace produces a slag which is skimmed from the molten pig iron. The slag contains most of the impurities associated with the iron-making process. A normal composition of the slag is 38 percent calcium oxide (CaO), 12 percent magnesium oxide (MgO), 37 percent silica (SiO_2), 10 percent alumina (Al_2O_3), a few percent manganous oxide (MnO), and 1 to 2 percent sulfur (S). The slag can be utilized as road fill, as a cement additive, or in other commercial applications. Thus, sulfur introduced by the direct injection of coal becomes a constituent of a useful by-product.

A large volume of low-grade gas is produced during the smelting process. This gas has a heating value in the range of 80 to 90 Btu per cubic foot. On leaving the furnace, this gas is cleaned of dust particles using conventional gas cleaning equipment. It is then used elsewhere in the plant for such purposes as preheating combustion air or for facility heating.

The design of a modern blast furnace contour (Figure 3) can be described as follows. From the top, or throat section, where the solid materials are placed on the bed, the furnace widens at a very low angle to allow the bed to expand slightly as it descends. There is a cylindrical section, or belly, approximately two-thirds of the distance down the furnace, which joins the upper tapered section to the lower tapered section, or bosh. The bosh is a short, tapered section which restricts the cross-section to compensate for the sintering and fusion of the bed as its temperature rises. The barrel-shaped section below the bosh contains the tuyeres and the hearth area.

Preheated combustion air, which may be enriched with oxygen, is blown into the blast furnace through the tuyeres. The zone within the furnace that is swept by the hot blast is called the raceway. The size of the raceway is dependent upon the hot blast temperature and pressure, the properties of the feedstock that has descended from the top of the furnace, and the physical characteristics of the blast furnace. Lowering of the raceway temperature, which can occur when large quantities of natural gas are used as an injected supplemental fuel, reduces blast furnace production rates. In such cases, the hot air blast is usually enriched with expensive oxygen to partially or fully restore the raceway temperature. Coal has a lower hydrogen content than gas or oil. Therefore, when coal is injected as a supplemental fuel it will not cause as severe a reduction in raceway temperatures. This makes coal an inherently preferable fuel in terms of blast furnace fuel rate and productivity.

In the proposed demonstration project, both granulated and pulverized coal will be injected into the blast furnaces in place of natural gas (or oil) as a blast furnace fuel supplement. The main facilities to be installed and demonstrated in this project include coal storage, drying, grinding, and injection.

Coal will be transported to the site by rail, unloaded with existing facilities, and stored in an area near the two blast furnaces to be retrofitted with BFGCI systems. For operations, the coal will be reclaimed from storage, dried, and crushed or ground in roller mills. The drying and milling facilities are designed to produce coals ranging in size consist from 80 weight percent minus 200 mesh (pulverized coal) to 30 weight percent minus 200 mesh (granulated coal). The dried, sized coal will then be pneumatically conveyed to a blast furnace injection facility consisting of pressurized coal storage and equipment for accurately metering the granulated or pulverized coal to multiple blast furnace tuyeres. Coal will be pneumatically conveyed from the controlled injection equipment to each of the 28 blast injection tuyeres in each furnace.

3.3 GENERAL FEATURES OF PROJECT

3.3.1 Evaluation of Developmental Risk

Subsequent to selection and as a part of the fact-finding process, DOE performed a detailed evaluation of the BSC project and determined it to be reasonable and appropriate. The evaluation focused on the project's technical, schedule, and cost risks. A team of experts from both within and outside DOE contributed to this evaluation. The data base for the evaluation included BSC-furnished documentation, DOE fact-finding discussions with BSC, and inspection of the proposed project site.

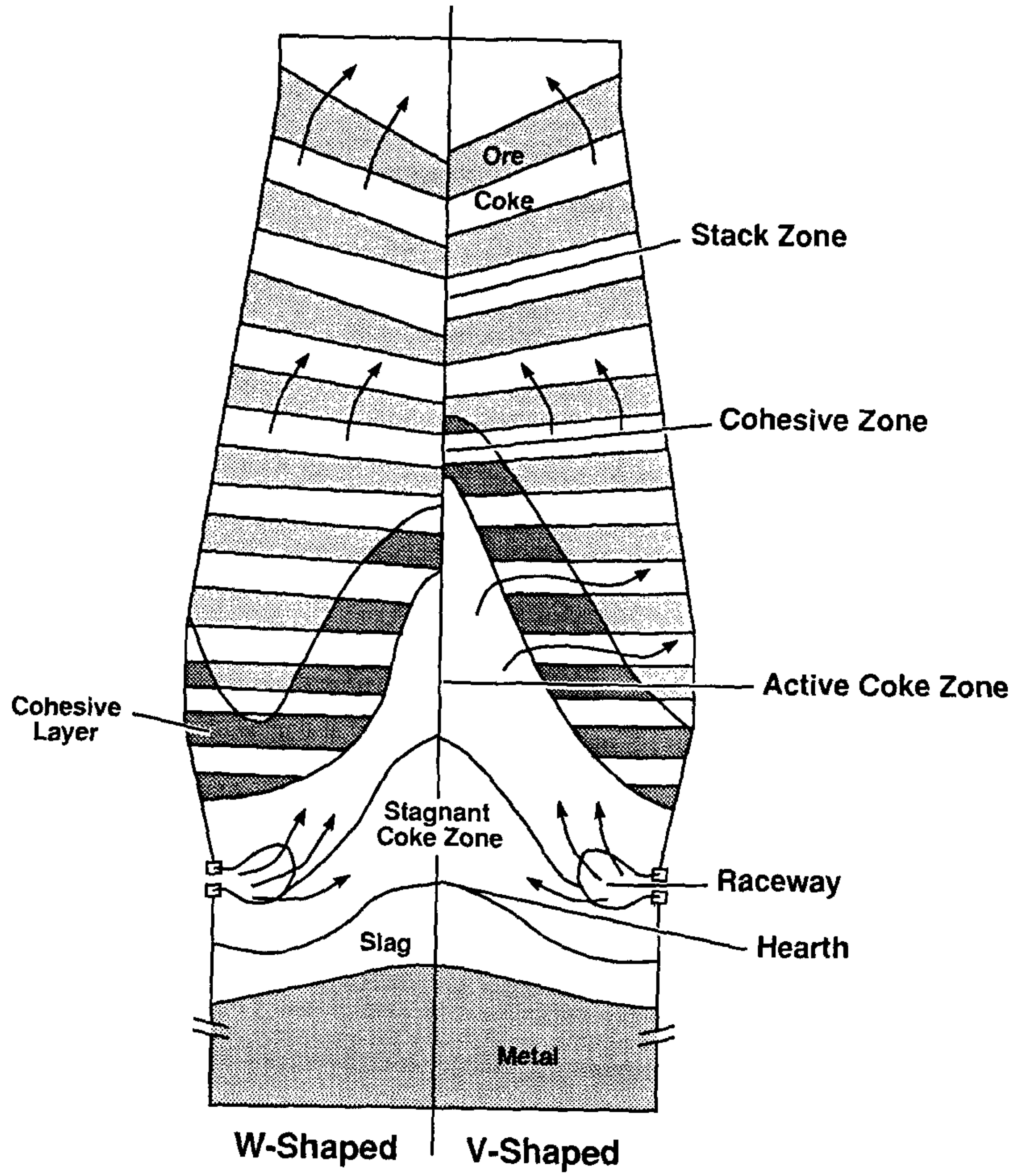

Figure 3. Zones In The Blast Furnace

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DOE does not anticipate any risks associated with either producing the coal size required for blast furnace injection or with physically injecting the coal into the blast furnace. All required equipment, instrumentation, and controls are commercially used in the steel industry or other industries at the scale required for the proposed project.

Technical uncertainties in the proposed project are primarily associated with blast furnace performance when injecting coal as a supplemental fuel. The main process uncertainties are the following:

- The rate at which coal can be continuously injected as a supplemental fuel into a modern, high-production blast furnace.
- The amount of coke that can be displaced by coal injection.
- Optimum particle size distribution of injected coals.
- Effect of coal rank on coal injection performance.
- Blast furnace refractory wear as a function of coal injection rate, coal size consist, and coal ash concentration.
- The ability to convert a blast furnace to coal injection "on-the-fly."
- Increased requirements for pig iron desulfurization.

The 68-month project schedule, which includes a 32-month demonstration period, allows sufficient time for the detailed design, procurement, construction, and start-up of BFGCI systems for both blast furnaces. No long lead items or other problems were identified which would prevent completion within the established schedule.

3.3.1.1 Similarity of Project to Other Demonstration and Commercial Efforts

The only blast furnace coal injection operations in North America have been at Armco's Ashland, Kentucky, plant. Injection was limited only to pulverized (finely ground) local coal into two blast furnaces with capacities less than 4,000 NTHM/day. The rates of injection were typically less than 200 pounds of coal per NTHM. No other BFGCI demonstrations are ongoing or planned in the U.S. Sole efforts to commercialize BFGCI in the U.S. are being pursued by ATSI and SM, the suppliers of the BFGCI system to be used in the Burns Harbor project.

In England, British Steel's Scunthorpe facility began using BFGCI technology in the mid-1980s and has operated to date with a total of more than 1,000,000 tons of granulated coal injected into three different furnaces. Rates of injection at Scunthorpe have been 250 pounds per NTHM since January 1989. The largest British Steel blast furnace to operate with BFGCI technology has a capacity of about 4,000 NTHM/day. The project proposed by BSC, using 7,000 NTHM/day blast furnaces, is the key step to effecting widespread implementation of successful, optimal, economically compelling BFGCI systems in the U.S.

3.3.1.2 Technical Feasibility

From its testing at Scunthorpe, British Steel has concluded that granular coal injection does not affect blast furnace performance any differently than pulverized coal injection. There has been no evidence that would indicate that the coarseness of the granular coal has resulted in poor utilization in the furnace. The level of carbon in the flue dust and the sludge from the gas cleaning plant at Scunthorpe show no discernible increase with coal injection, and the data indicate that full combustion of the coal takes place within the furnace. In fact, operations to date have indicated that granulated coal injection contributes to an increased productivity of the furnace by allowing operation with substantially lower coke requirements.

In the English testing, the hot metal quality was found to be independent of the coal injection rate, apart from the normal effect of an increased sulfur load due to the use of coal. All sulfur in the coal reported with the slag or hot metal; none was exhausted in the blast furnace offgas.

Extrapolation of the results of testing and continued operation in England to the application of BFGCI at U.S. furnaces using U.S. coals raises no questions concerning the technical feasibility of the proposed project.

3.3.1.3 Resource Availability

All of the resources required for the project are available. BSC will provide the Participant share of the project financing by way of internally generated funds.

The 6 acres required for the BFGCI system equipment and coal storage area will be located on the Burns Harbor plant site, which is owned by BSC and consists of over 3,300 acres. All infrastructure services are available including water, rail siding, coal unloading facilities, blast furnaces, waterway and highway access, electric service, and wastewater treatment plant.

Resources for lifetime operation of the BSC project including manpower, coal, water, and transportation are available in the region. BSC now has over 6,000 combined skilled and unskilled employees at the Burns Harbor plant. An additional seven to eight employees will be required to operate the BFGCI system. Sufficient skilled labor is readily available in the Burns Harbor region.

3.3.2 Relationship Between Project Size and Projected Scale of Commercial Facility

The proposed project will be conducted at full scale on two large, modern, high-capacity blast furnaces. Only three blast furnaces in the United States are larger than the Burns Harbor furnaces to be used for the demonstration. Therefore, the data and operating experience derived from the project will be directly applicable to the cost justification, design, construction, and operation of nearly every blast furnace in the country. Furthermore, once successful demonstration of the BFGCI technology is completed in this project, BSC anticipates that it will proceed with installation of a scaled-up system at the one larger blast furnace which it owns, viz., the "L" furnace at Sparrows Point, Maryland. This indicates that the demonstration project is at a scale sufficient to enable deployment of the BFGCI technology at every existing furnace in the nation.

3.3.3 Role of Project in Achieving Commercial Feasibility of Technology

The demonstration project will be a full-scale application of the commercial version of the BFGCI system that will be offered to the integrated steel industry. Key features of a commercial BFGCI system that will be demonstrated include:

- Expanding the use of domestic coals in a fuel application area currently dominated by oil and gas.
- A system that provides granulated coal suitable for injection into all U.S. blast furnaces.
- A system that will function satisfactorily with U.S. coals.
- A system which is essentially nonpolluting.
- A system which results in a smoother operating blast furnace by minimizing slipping and hanging of the furnace burden within the furnace.
- Fuel injectors that will accurately control the fuel flow over a 10:1 flow ratio.
- A system that will reduce the amount of coke required by a greater amount than can be achieved by using oil or gas injection.
- A more cost effective system than with alternative fuels.

4.0 ENVIRONMENTAL CONSIDERATIONS

The NEPA compliance procedure, cited in Section 2.2, contains three major elements: a Programmatic Environmental Impact Statement (PEIS); a pre-selection, project-specific environmental review; and a post-selection, site-specific environmental document. 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, capturing 100 percent of its applicable market. These impacts were compared to 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 decision-making was completed for internal DOE use. The review summarized the strengths and weaknesses of each proposal against the environmental evaluation criteria. It included, to the extent possible, a discussion of alternative sites and/or processes reasonably available to the Offeror, practical mitigating measures, and a list of required permits. This analysis was provided for consideration of the Source Selection Official in the selection of projects.

To complete the final element of the NEPA strategy, the Participant (Bethlehem Steel Corporation) submitted to the DOE the environmental information specified in the PON. This detailed site- and project-specific information forms the basis for the NEPA documents prepared by DOE. These documents, prepared in full compliance with NEPA (40 CFR 1500-1508) and DOE guidelines for NEPA compliance (52 FR 47662), must be approved before federal funds can be provided for any activity that would limit the choice of reasonable alternatives to the proposed action.

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.

Control technologies, such as proposed by the Participant, are similar to those used at utility and industrial boilers and can be applied to industrial processes that generate SO_2, oxides of nitrogen, and particulate matter with similar results. Demonstration of the BFGCI technology will reduce the amount of coke that is normally required per ton of hot metal produced, thus proportionately reducing the emissions from the coke-making process. The emissions generated by the blast furnace itself will remain virtually unchanged; the gas exiting the blast furnace is clean, containing no measurable SO_2 or NO_x. A small amount of NO_x is generated by the coal-drying process prior to injection into the blast furnace. Particulate matter is removed from the gas stream with a conventional cyclone and wet scrubber. Particulate matter generated from the coal preparation plant is expected to increase slightly. Water use will result in little additional need. Sulfur will be removed by the limestone fluxes added to the blast furnace and exit the furnace in the slag material. Due to the ash content of the coal being injected, a slight increase in quantity of slag is anticipated. The slag is readily saleable as construction aggregate material and rock wool.

From a programmatic standpoint, the largest reductions in emissions resulting from commercialization of the BFGCI technology will occur in the coke-making process. As the BFGCI technology reaches full market penetration, the amount of coke required for blast furnaces will decrease, thus reducing the emissions associated with its production.

5.0 PROJECT MANAGEMENT

5.1 OVERVIEW OF MANAGEMENT ORGANIZATION

As the signatory to the Cooperative Agreement, BSC will be responsible for all aspects of the project. It will accomplish the project objectives by means of the organizational relationships shown in Figure 4. Since BSC is the owner of the project site and the owner/operator of the furnaces to be repowered with BFGCI technology, it will also be the owner, manager, and operator of the demonstration plant. BSC will manage the project through a Program Director, who will be assisted by a team of technical and administrative personnel. A steering committee comprised of key BSC management personnel will provide overall direction for the project. Responsibilities for Phases I and II of the project will be carried out by BSC's Project Engineering Department, while

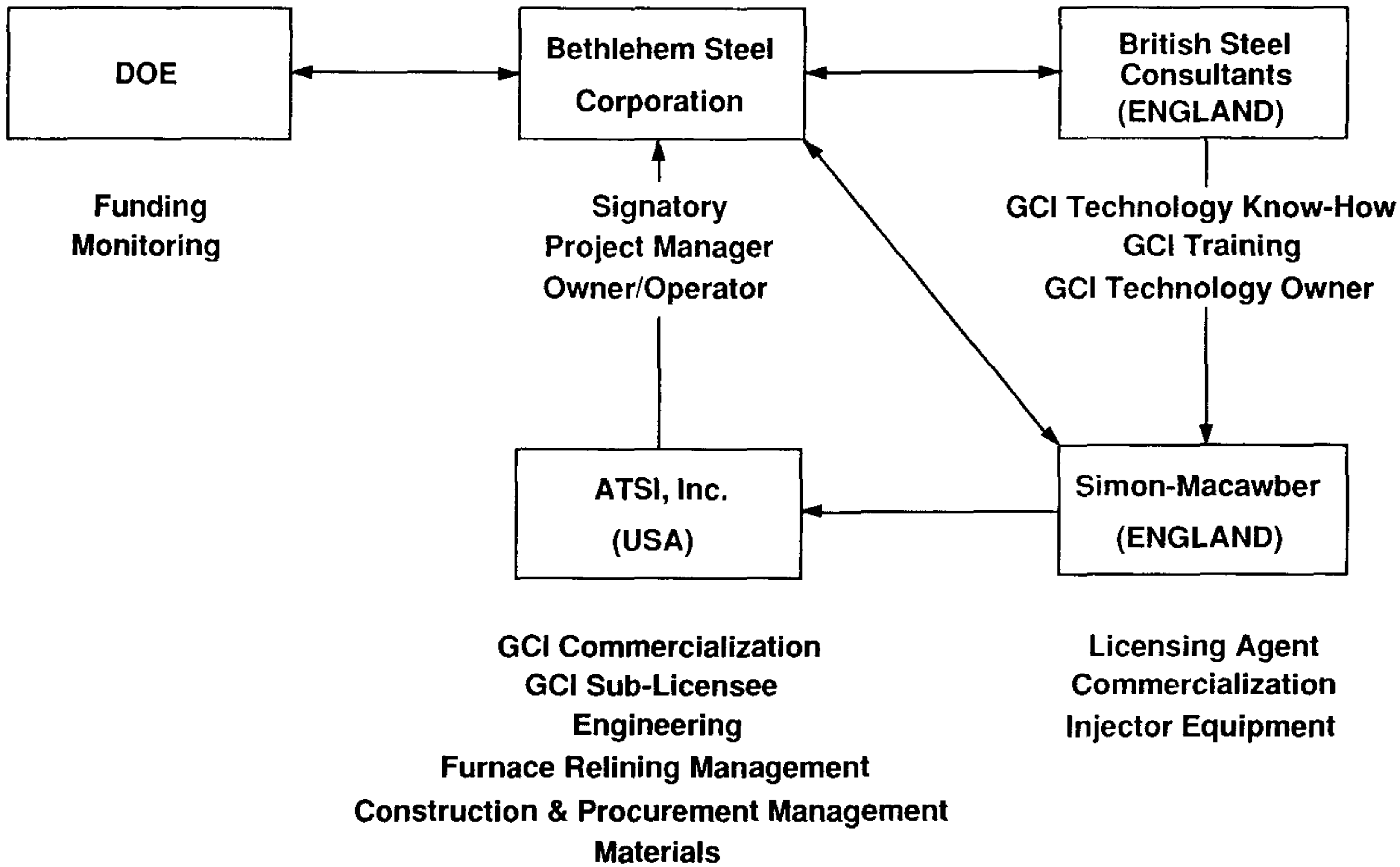

Figure 4. Project Organization

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those associated with Phase III will be conducted through BSC's Burns Harbor Operations.

5.2 IDENTIFICATION OF RESPECTIVE ROLES AND RESPONSIBILITIES

5.2.1 DOE

DOE will be responsible for monitoring all aspects of the project and for granting or denying approvals required by the Cooperative Agreement. A DOE Project Manager (COR) will be designated by the DOE Contracting Officer. The Project Manager will be the primary point of contact for the project and will be responsible for DOE management of the project.

5.2.2 Participant

BSC, as the Participant, will be responsible for all aspects of the project, including design, permitting, construction, operation, data collection, and reporting. BSC will provide the Participant share of project funding, perform balance of plant design, oversee construction and equipment installation, and operate the BFGCI systems in conjunction with its normal day-to-day operation of the two blast furnaces to be repowered with the demonstration technology. BSC will utilize the services of ATSI, Inc., for process design, construction engineering, and procurement and will also contract for the construction of the facility. BSC will provide the results of the project to the domestic steel industry, thus accelerating commercial utilization of the BFGCI technology.

5.3 PROJECT IMPLEMENTATION AND CONTROL PROCEDURES

BSC will prepare and maintain a project management plan that presents project procedures, controls, schedules, budgets, and other activities required to adequately manage the project. This document, which will be finalized shortly after execution of the Cooperative Agreement, will be used to implement and control project activities. Throughout the course of the project, reports dealing with the technical, management, cost, and environmental monitoring aspects of the project will be prepared and provided to DOE. The project will be divided into three budget periods, each requiring DOE approval prior to initiation.

5.4 KEY AGREEMENTS IMPACTING DATA RIGHTS, PATENT WAIVERS, AND INFORMATION REPORTING

With respect to data rights, DOE has negotiated terms and conditions that will generally provide for rights of access by DOE to all data generated or used in the course of or under the Cooperative Agreement by BSC and its subcontractors. DOE will have unlimited rights in nonproprietary contract data and limited rights of access to proprietary data utilized in the performance of the Cooperative Agreement. DOE will have the right to have relevant proprietary information delivered to it under suitable conditions of confidentiality.

With regard to patents, data, and other intellectual property, BSC has made an express contractual commitment to exercise its best efforts to commercialize, in the United States, the BFGCI technology demonstrated in this project. This will be accomplished through an agreement between BSC and British Steel which commits British Steel to promote commercial-size facilities worldwide for responsible applicants and to provide appropriate technical assistance, training, and licensing of patents and proprietary technology.

5.5 PROCEDURES FOR COMMERCIALIZATION OF THE TECHNOLOGY

Successful completion of the BSC project will be an important step in the commercialization of BFGCI technology in the United States. While commercial application of the technology has been achieved in England, there is no experience with the size of furnaces or the coal injection rates which will be utilized in this Clean Coal demonstration. In addition, to earn the confidence of domestic steel manufacturers, it is important that the technology be demonstrated on a variety of U.S. coals in U.S. furnaces. Coal type is important because the chemical characteristics of the coal may have an impact on furnace performance. Demonstration at U.S. installations is important because domestic blast furnaces are generally operated differently than European furnaces, where the use of pelletized ore is not nearly so common.

ATSI, supported by SM and British Steel as required, will market the BFGCI technology in the United States. Since ATSI regularly provides procurement and construction management for the steel industry, it is in a good position to promote the results of the demonstration and the advantages of the technology to potential users. Once the BFGCI technology is successfully demonstrated at Burns Harbor, its potential cost savings and its availability to the steel industry should result in substantial market penetration. The fully commercial size of the demonstration project system, coupled with its continued use at a commercial installation beyond the end of the project period, should provide the steel industry with the confidence it needs to plan for the repowering of other furnaces with the BFGCI technology.

6.0 PROJECT COST AND EVENT SCHEDULING

6.1 PROJECT BASELINE COSTS

The estimated cost and the cost sharing for the work to be performed under the Cooperative Agreement are as follows:

Pre-Award		
DOE Share	$ 19,530	21.7%
Participant Share	$ 70,470	78.3%
Total	$ 90,000	100%
Phase I		
DOE Share	$ 510,000	10%
Participant Share	$ 4,590,000	90%
Total	$ 5,100,000	100%
Phase II		
DOE Share	$ 29,535,000	34%
Participant Share	$ 57,465,000	66%
Total	$ 87,000,000	100%
Phase III		
DOE Share	$ 1,195,000	2.3%
Participant Share	$ 50,415,000	97.7%
Total	$ 51,610,000	100%
Total Estimated Project Cost		
DOE Share	$ 31,259,530	21.7%
Participant Share	$112,540,470	78.3%
Total	$143,800,000	100%

The project has been divided into a pre-award period and three budget periods as shown in Figure 5. At the beginning of each budget period, DOE will obligate sufficient funds to pay its share of the expenses for that period.

6.2 MILESTONE SCHEDULE

The project is divided into three phases and is expected to take 68 months to complete. The phases and their expected durations are as follows:

1.	Phase I: Design and Permitting	17 months
2.	Phase II: Construction and Start-Up	37 months
3.	Phase III: Operation and Data Collection	32 months

Phases I and II overlap 12 months. Phases II and III overlap 6 months. The completion of the NEPA process will be the basis for beginning Phase II.

The project schedule and major milestones are shown in Figure 5.

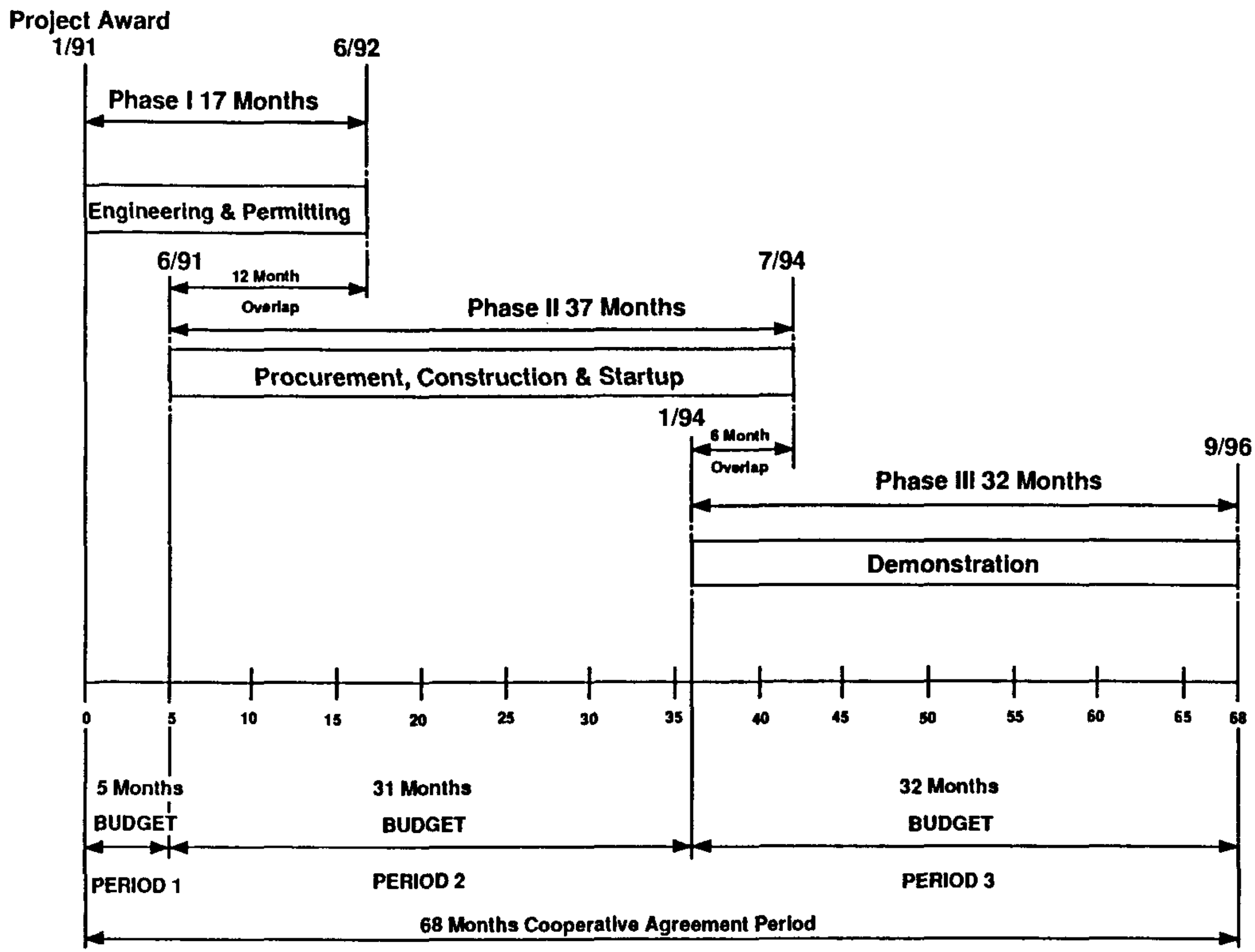

Figure 5. Bethlehem Steel Corporation BFGCI Project Schedule

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6.3 REPAYMENT AGREEMENT

Based on DOE's recoupment policy as stated in Section 7.4 of the PON, DOE is to recover an amount up to the Government's contribution to the project. The Participant has agreed to repay the Government in accordance with a negotiated Repayment Agreement to be executed at the time of award of the Cooperative Agreement.