

TECHNICAL PROGRESS REPORT - FIRST QUARTER

Date: 1 September 1992

Contract Title: Industrial Pulverized Coal  
Low NO<sub>x</sub> Burner: Phase I

Contract Number: DE-AC22-92PC92151

Contract Period: 04-01-92 to 03-31-93.

Contractor Name: Arthur D. Little, Inc.  
20 Acorn Park  
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Reporting Period: 04-01-92 thru 06-30-92

**Introduction**

During the three-month reporting period covering April, May and June, 1992, the project team comprising Arthur D. Little, Inc. (ADL), Massachusetts Institute of Technology (MIT), and Hauck Manufacturing Company, (1) developed the overall program management plan, (2) partially completed a market survey to identify suitable coals for modeling of the low-NO<sub>x</sub> burner design and performance, and for Phase II burner tests, and (3) defined the preliminary burner design specifications, sized the prototype burner, and produced the first design sketch.

**Burner Design and Modeling Plan**

Several steps leading to the optimization of the burner design through modeling have been identified and included in the Plan. These steps include:

- (•) Review of coal devolatilization chemistry and rates to determine the time required for the evolution of fuel-nitrogen and hydrocarbons from the coal during the heating up process. (Figure 1).
- (•) Kinetic calculation of the conversion rates of fuel-bound nitrogen species to N<sub>2</sub> and to NO<sub>x</sub>, at various fuel equivalence ratios in the burner's primary fuel-rich stage. Equivalence ratio limits, and the necessary residence times in the fuel-rich zone will be determined. (Figure 1)
- (•) Fluid dynamic modeling, in combination with the chemical kinetic study, to characterize (a) the mixing process of the char-bearing primary (fuel-rich) mixture with the secondary (staged) air, and (b) the process of

MODELING PLAN FOR THE PRIMARY STAGE OF THE LOW NO<sub>x</sub> PULVERIZED COAL BURNER

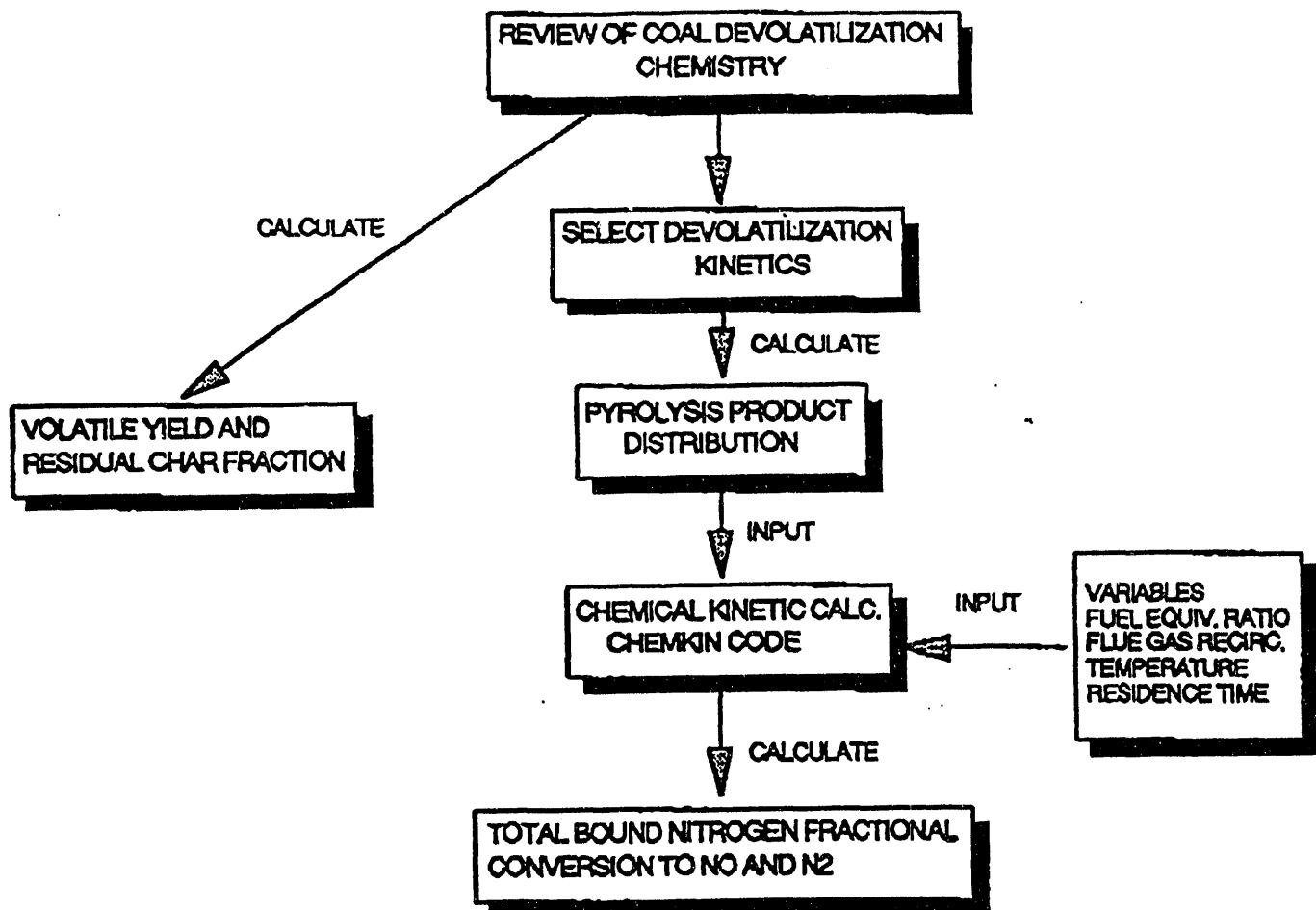


Figure 1

char burn-out. The residence time of complete oxidation of the char will be determined, and the lowest achievable  $\text{NO}_x$  concentration, using this burner concept, will be estimated. The first draft of the model-optimized burner design will be prepared. (Figure 2).

### **Economic and Marketing Evaluation**

Market evaluation of industrial pulverized coal usage, and of typical industries and applications where the low- $\text{NO}_x$  burner may be sold, was partially completed at the end of this reporting period. The study identified three coals that may adequately meet the requirements of the low- $\text{NO}_x$  burner modeling study, and of the intended industrial applications. These were: (a) Pittsburgh Seam Bituminous, (b) Pittsburgh #8, and (c) Utah Bituminous. The results will be reported in the second quarterly report.

### **Preliminary Burner Design Specifications**

The first burner design, for modeling studies, was developed for a nominal output of 5.0 million Btu/hr. All input and process parameters, and all major dimensions of the burner have been determined. Burner design sketch was developed.

Standard jet pump geometry of the fuel-rich burner flow path (US Patents #4,445,842 and #3,990,831), has been modified for use with pulverized coal. Staged air was added. Staged air, in conjunction with recirculated flue gas, has been found by ADL, MIT and other researchers to be effective in  $\text{NO}_x$  reduction.

No attempt has been made to achieve compactness of design. The primary and secondary air inlets and flow passages are separate, although in the industrial burner they will be combined. Flue gas may be drawn into the burner either from the hot furnace chamber, or from the flue stack after recuperation. However, to satisfy the energy requirements for volatilizing the coal, flue gas temperature above 2000°F may be needed.

### **Results**

With the preliminary burner design completed, and suitable coals for the modeling study selected, the project is ready to proceed to the kinetic modeling tasks at MIT.

### **Plans for the Next Reporting Period**

Our priorities during the next reporting period will focus on expediting of the subcontract with MIT, on the resumption of project team interactions, and on re-starting the modeling study.

### **DISCLAIMER**

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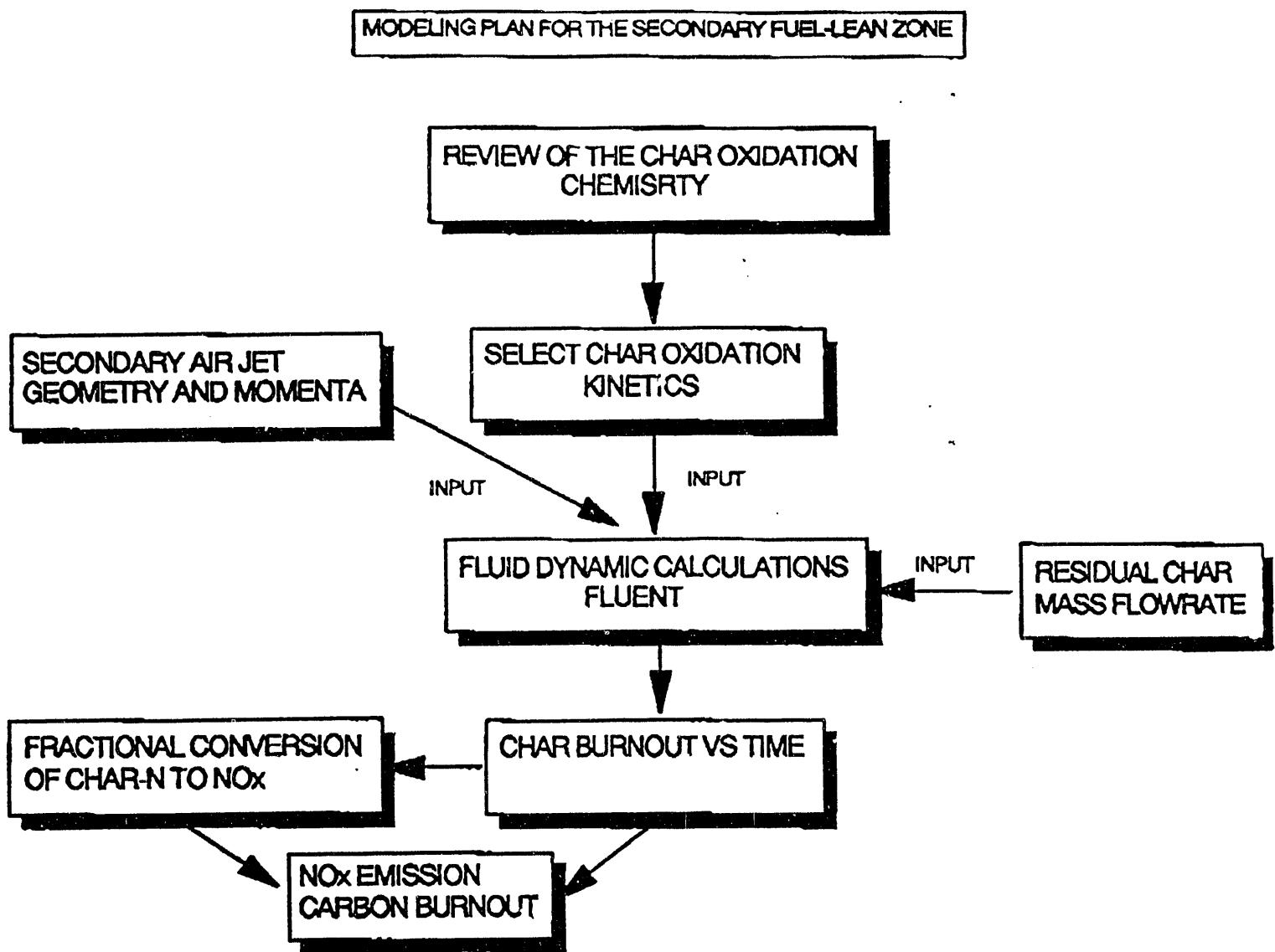


Figure 2

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