**HOT GAS CLEANUP TEST FACILITY FOR GASIFICATION AND
PRESSURIZED COMBUSTION**

**QUARTERLY TECHNICAL PROGRESS REPORT
OCTOBER 1 - DECEMBER 31, 1991**

Prepared by

SOUTHERN COMPANY SERVICES, INC.
800 Shades Creek Parkway
P.O. Box 2625
Birmingham, Alabama 35202

Work Performed Under DOE Cooperative Agreement No. DE-FC21-90MC25140

U.S. DEPARTMENT OF ENERGY
Morgantown Energy Technology Center
3610 Collins Ferry Road
P.O. Box 880
Morgantown, West Virginia 26507-0880

DISCLAIMER

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor any agency thereof, nor any of their employees, make any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, mark, manufacturer or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

**HOT GAS CLEANUP TEST FACILITY FOR GASIFICATION AND
PRESSURIZED COMBUSTION
QUARTERLY TECHNICAL PROGRESS REPORT
OCTOBER 1 - DECEMBER 31, 1991**

CONTENTS

<u>Section</u>	<u>Page No.</u>
1.0 INTRODUCTION AND SUMMARY	1
2.0 REVIEW OF TECHNICAL PROGRESS	1
2.1 Project Management	1
2.2 Task 1.1 Environmental Permit Information	2
2.3 Task 1.2 Conceptual Design	2
2.3.1 Subtask 1.2.1 Design Bases	2
2.3.1.1 Design Verification Testing	2
2.3.1.2 Assessment of Particulate Control Testing Issue .	3
2.3.2 Subtask 1.2.2 Gasifier/Combustor and Hot Stream Design .	4
2.3.3 Subtask 1.2.3 Balance-of-Plant Design	5
2.3.4 Subtask 1.2.4 Particulate Collection	5
2.3.4.1 Characterization of TRTU Samples	5
2.3.4.2 Particulate Apparatus and Instrumentation	14
2.3.4.3 Particulate Control Devices Request for Proposals	15
3.0 PLANS FOR FUTURE WORK	15
4.0 REFERENCES	16

APPENDIX

1.0 INTRODUCTION AND SUMMARY

This quarterly technical progress report summarizes work completed during the Fifth Quarter of the First Budget Period, October 1 through December 31, 1991, under the Department of Energy (DOE) Cooperative Agreement No. DE-FC21-90MC25140 entitled "Hot Gas Cleanup Test Facility for Gasification and Pressurized Combustion." The objective of this project is to evaluate hot gas particle control technologies using coal-derived gas streams. This will entail the design, construction, installation, and use of a flexible test facility which can operate under realistic gasification and combustion conditions. The major particulate control device issues to be addressed include the integration of the particulate control devices into coal utilization systems, on-line cleaning techniques, chemical and thermal degradation of components, fatigue or structural failures, blinding, collection efficiency as a function of particle size, and scale-up of particulate control systems to commercial size.

The major emphasis during this reporting period was finishing the conceptual design for the test facility and discussions on the potential expansion of the test facility. The EPRI Participation Agreement was finalized in November. Additional technical and cost information for the Transport Reactor Demonstration Unit at the University of North Dakota Energy and Environmental Research Center (UNDEERC) was provided to DOE/METC. A review meeting for the 50 percent completion mark of the conceptual design for the facility was held in October. Discussions occurred with DOE/METC and SCS on expanding the test facility to address system integration issues of hot particulate removal in advanced power generation systems. M. W. Kellogg (MWK) completed the data reduction for the TRTU test runs and sent filter samples to Southern Research Institute (SRI). SRI continues to characterize the TRTU filter samples and compare them to particulates from other processes. MWK completed their portion of the conceptual design in November. All the balance-of-plant design work for electrical, mechanical and instrumentation and control areas have been completed by SCS. SRI has finalized the conceptual design of the particulate sampling system. A preliminary draft of the request for proposal for the procurement for the particulate control devices (PCDs) was prepared by SRI.

It should be noted that this report includes accounts of progress made by MWK and SRI.

2.0 REVIEW OF TECHNICAL PROGRESS

2.1 PROJECT MANAGEMENT

The negotiations for the EPRI Participation Agreement were completed in late October and the agreement was executed in early November. Other project management activities included SCS issuing the Engineering Coordination Procedures to the project team to help facilitate better communications with the design team. SCS also providing DOE/METC with technical and cost information for the Transport Reactor Development Unit (TRDU) work at UND/EERC. The TRDU work is expected to begin next quarter.

A review meeting for the 50 percent completion mark of the conceptual design for the facility was held on October 22nd at Southern Clean Fuels in Wilsonville, AL. The presentation material from the meeting and a list of attendees is in the Appendix. Prior to the review meeting, the Facility Design Document was prepared by SCS Research & Environmental Affairs and sent to members of the project team. The document contained the design information to the 50 percent completion point for the conceptual design and will continue to expand as the design effort continues. A list of action items from the meeting is also listed in the Appendix.

Discussions with DOE/METC and SCS occurred during this time period on the potential of expanding the test facility to address system integration issues for particulate control devices with other advanced power generation systems. A preliminary "strawman" recommendation outlining the possible expansion of the facility was submitted to DOE/METC to facilitate further discussions. DOE/METC requested in December a cost and level-of-effort estimate for extending the conceptual design of the facility to include the additions of the following units:

1. Carbonizer/Pressurized Circulating Fluidized Bed Gas Source.
2. Hot Gas Cleanup Units to mate to all the gasstreams.
3. Combustion Gas Turbine.
4. Fuel Cell and associated gas treatment.
5. Externally Fired Gas Turbine/Water Augmented Gas Turbine.

A proposal from SCS to include these additions will be provided to DOE in the first quarter of 1992.

2.2 TASK 1.1 ENVIRONMENTAL PERMIT INFORMATION

The heat and material balances from the MWK process release package for the conceptual design of the Hot Gas Cleanup Test Facility (HGCTF) were reviewed and will be used to provide additional environmental information for DOE use to support the NEPA documentation effort and used in the permitting of the test facility. Transport Reactor Test Unit (TRTU) spent bed drain samples from gasification runs were sent by MWK to SCS for Hazardous Waste Evaluation. Preliminary analysis indicates that the material would not be classified as a hazardous waste. Plans are under way to begin air modeling for the site.

2.3 TASK 1.2 CONCEPTUAL DESIGN

2.3.1 Subtask 1.2.1 Design Bases

2.3.1.1 Design Verification Testing - Transport Reactor Test Unit (TRTU)

During this quarter, M.W. Kellogg completed the revision of the coal gasification and combustion spreadsheets for the TRTU and started incorporating solid balances into the spreadsheets. Twelve filter dust samples from six different

gasification runs with the TRTU were sent to SRI for detailed particulate analysis.

A draft report describing the TRTU testing and the completion of the conceptual design of the facility is being prepared. The figures and tables for this report have been nearly completed. 80% of the test report content has been completed. Sections have been issued for internal review and comments have been received.

SCS, MWK and UNDEERC have been developing a Scope of Work and cost estimate for testing of a larger transport reactor to be operated in the gasification mode at UNDEERC. This unit, called the Transport Reactor Development Unit (TRDU), will confirm the design basis for the transport reactor concept and will facilitate the installation of a pilot scale reactor at Wilsonville by reducing shakedown time. The TRDU will be approximately ten times large (feed basis) than the TRTU. The TRDU will be operated for about four months. The revised Scope of Work and cost estimate was submitted to DOE-METC on October 14, 1991.

2.3.1.2 Assessment of Particulate Control Testing Issues

SRI's primary role in developing the conceptual design basis is in the areas of particulate control and particulate sampling and characterization. During this quarter, SRI continued work on assessing particulate control issues that affect the conceptual design. A summary of this assessment was presented at the design review meeting held at Wilsonville on October 22, 1991. A written discussion of this subject was also submitted to SCS for inclusion in the HGCTF design document. A copy of the written discussion was included in the last quarterly report. The following is a list of the major issues that were addressed during the presentation and discussions:

- Type(s) of particulate control devices (PCDs) selected for evaluation
- Need to demonstrate long-term durability
- Variety of on-line cleaning methods
- Differing requirements for access to PCD
- Heat loss considerations
- On-line monitoring requirements
- Requirements for manual sampling
- Other data acquisition requirements
- Coal and ash sampling requirements
- Startup requirements
- Characteristics of particles from transport reactor test unit (TRTU)

A copy of the document dealing with these issues was included in the last quarterly report

Particle characteristics data base. During this quarter, work also continued on the analysis of the particle characteristics data base, which was described in the previous quarterly report. The data base contains data on 72 different samples from 21 distinct sources. The sources include three pressurized fluidized-bed combustors (PFBCs), three gasifiers, two atmospheric fluidized-bed combustors (AFBCs), and three circulating fluidized-bed combustors (CFBCs). The

data base includes data on sample source and type, particle size, surface area, porosity, density, drag-equivalent diameter, gas-flow resistance, morphology factor, tensile strength, and chemical composition. Scanning electron microscope (SEM) photographs of the samples are also cross-referenced in the data base.

Analysis of the data base began by grouping the data by process type, primarily, to identify any significant differences in the characteristics of particles generated by the different processes (i.e., gasification, PFBC, AFBC, and CFBC). Based only on the quantitative data available from SRI's characterizations performed to date, the data base does not appear to be adequate to distinguish between the different process types. However, work performed this quarter suggested that certain differences are evident in the SEM photographs of the samples from the various types of processes. For example, it was noted that the particles generated by the TRTU in the combustion mode appeared to be similar in size and shape to the particles generated by the New York University (NYU) PFBC. Particles from the Tidd PFBC appeared to be very similar to particles from the Grimethorpe PFBC, but the Tidd and Grimethorpe particles were smaller than the NYU and TRTU particles. The NYU and TRTU samples also contained shards that were not evident in the Tidd and Grimethorpe samples. The shards appeared to be fragments of cenospheres that had been blown apart.

Particles from the Texaco gasifier appeared to be similar in size and shape to particles from the Westinghouse gasifier. Particles from the KRW gasifier were much smaller than the particles from the Texaco and Westinghouse gasifiers. (This may be simply the result of a more efficient cyclone system on the KRW gasifier.) Shards were also evident in the samples from the KRW gasifier. In the gasifier mode, the TRTU produced particles that were about the same size as the particles from the Texaco and Westinghouse gasifiers. However, the morphology of the TRTU particles was fundamentally different from that of the Texaco and Westinghouse particles. The TRTU samples appeared to contain many cenospheres. No cenospheres were evident in the other gasifier samples, but the shards in the KRW samples could be fragments of cenospheres that were broken apart.

SRI has begun a systematic comparison of the SEM photographs and characteristics of the various PFBC and gasifier samples contained in the SRI data base on particle characteristics. The results of this comparison can be included in the request for proposals (RFP) for PCDs to be tested at the HGCTF.

2.3.2 Subtask 1.2.2 Gasifier /Combustor and Hot Stream Design

The Process Release, Process Control Philosophy and Materials of Construction packages were revised based on reviews by MWK and SCS, and comments from the 50% review meeting held in Wilsonville. In late November, MWK completed their portion of the conceptual design and cost estimate, and issued all conceptual design packages to SCS for use in the balance-of-plant design. After a review of the conceptual plant layout and the cost estimate, the entire package will be reissued.

2.3.3 Subtask 1.2.3 Balance-of-Plant Design

All design work was completed in the electrical, mechanical, and instrumentation and controls areas with the exception of the baghouse/sulfur removal system. In the civil area, final revisions to the site layout are almost complete and 75% of the loads in the process structure have been evaluated in order to estimate foundation and structural steel costs. The remainder of the design work should be completed in January.

The overall cost estimate based on the conceptual design will be finalized shortly after completion of the remaining design work and the receipt of the final package from MWK.

2.3.4 Subtask 1.2.4 Particulate Collection

2.3.4.1 Characterization of TRTU samples

During this quarter, SRI completed work on characterizing the latest set of samples from the TRTU (twelve samples). All of the samples were produced under gasification conditions using Longview limestone and three different coals: Illinois No. 6 bituminous, Western Kentucky No. 6 bituminous, and Wyodak subbituminous. The gasifier pressure was 85 psig in all cases; the riser temperature varied from 1750 to 1845°F. Two of the twelve samples were produced using coal ground to a mean particle size of 50 µm, while the other ten samples were produced using a mean coal particle size of 200 µm. The 50-µm particle size is believed to be more representative of the coal grind currently planned for the Wilsonville test facility. Based on the test conditions given by Kellogg, the following four samples were selected for characterization:

- H-1962-G3A Wyodak subbituminous: 1750°F riser temperature, 200-µm grind
- H-1962-G5C Illinois No. 6 bituminous: 1790°F riser temp., 200-µm grind
- H-1962-G7A Illinois No. 6 bituminous: 1780°F riser temp., 50-µm grind
- H-1962-G8A W Kentucky No. 6 bituminous: 1845°F riser temp., 200-µm grind

Specific characterization tests to be applied to the TRTU samples were selected based on the goals of this subtask. The first goal is to compare the characteristics of the TRTU samples to those of other types of particles in the SRI particulate data base. This should provide insight into the expected behavior of the transport reactor particles with respect to filtration at high temperatures and pressures. The second goal is to provide data on particle characteristics that will help the particulate control device (PCD) vendors prepare their proposals for the Wilsonville facility. By comparing the transport reactor particulate characteristics with those of other types of particles that the PCD vendors have tested previously, the vendors should be able to make more informed decisions concerning PCD design and application. The specific tests selected for these TRTU samples are listed below. The results of these tests were transmitted to M.W. Kellogg in a letter report dated January 9, 1992.

- Volumetric mean particle size by Coulter Counter
- Aerodynamic mean particle size by Shimadzu centrifugal particle sizer

- BET specific surface area by nitrogen adsorption technique
- True particle density by helium pycnometer
- Tensile strength by electrostatic tensiometer
- Microscopic examination by scanning electron microscope (SEM)
- Morphology factor determined from particle size and surface area

The size distributions obtained from the Coulter Counter size analyzer are shown in Figure 1. Those obtained from the Shimadzu centrifugal analyzer are shown in Figure 2. Both sets of size distributions show that all four samples had similar size distributions. Both the Coulter Counter and Shimadzu results suggest a slightly higher mass fraction of fine particles in the sample produced from the Wyodak coal (Sample No. H-1962-G3A). This result is consistent with previous research that has documented the tendency of Western subbituminous coals to produce more fine ash particles than do bituminous coals (Sarofim, et al, 1977; Flagan and Friedlander, 1978; Dahlin and Altman, 1983; Dahlin, et al, 1986). The size distributions for the Illinois No. 6 and Western Kentucky No. 6 bituminous coals were very similar, which might be expected, because of the proximity of the two coal seams and the similarities in coal composition (Richardson and Nielsen, 1981).

The Shimadzu results suggest that the particles larger than about 10 μm have a well-defined bimodal size distribution, with the two modes centered at about 15 μm and 30 μm . The smaller of these two modes is also evident in the Coulter Counter results, but appears to be centered at a slightly smaller particle size. The larger mode is much less pronounced in the Coulter Counter results. One possible explanation for this discrepancy is that the large particle mode contains a significant amount of carbon, which would not be detected by the Coulter Counter since carbon is much more electrically conductive than fly ash.

The size distributions obtained from the two different grinds of the Illinois coal (mass mean particle sizes of 50 μm and 200 μm) were surprisingly similar over virtually the entire range of particle sizes resolved by the analyzers. The only significant difference is the appearance of an ultrafine particle mode, centered at 0.15 μm , in the ash from the 50- μm grind. This ultrafine mode is not evident in the distributions from the other three samples. The potential effect of this ultrafine mode on PCD performance cannot be projected from available data; however, this mode constitutes about 5% of the total particulate mass. This is a much larger contribution than typically seen in size distributions of fly ash from pulverized coal combustion, where the contribution of particles in this size range (0.1 to 0.2 μm) is typically less than 1 wt %.

Mass mean particle diameters (MMDs) determined from the Coulter Counter and Shimadzu analyses are summarized below in Table 1. It should be noted that the Coulter Counter MMDs are volumetric mean diameters, while the Shimadzu MMDs are aerodynamic mean diameters.

Figure 1. Particle Size Distributions Measured by Coulter Counter

Figure 2. Particle Size Distributions Measured by Shimadzu Centrifugal Analyzer

Table 1
Measured Characteristics of Coal Gasification Filter Samples

Sample No.	Sample description	Coulter MMD, μm	Shimadzu MMD, μm	Specific surface area, m^2/g	Morphology factor	True density, g/cm^3	Tensile strength, Nt/m^2
H-1962-G3A	Wyodak, 200- μm	6.1	17.8	300	660	2.14	1.3
H-1962-G5C	Ill. No. 6, 200- μm	7.5	15.7	241	690	2.29	0.8
H-1962-G7A	Ill. No. 6, 50- μm	7.4	13.5	353	980	2.27	0.4
H-1962-G8A	W. Kentucky No. 6, 200- μm	7.3	15.3	69	190	2.31	0.5

Ideally, the ratio of the Shimadzu MMD to the Coulter Counter MMD should be equal to the square root of the particle density, since aerodynamic diameters are based on a density of $1 \text{ g}/\text{cm}^3$. Assuming a particle density of $2.5 \text{ g}/\text{cm}^3$, the aerodynamic diameters calculated from the Coulter Counter MMDs range from 9.6 to 11.9 μm . The Shimadzu MMDs are significantly higher than these values. Of course, the two techniques are based on different principles, so perfect agreement should not be expected. The Coulter Counter MMDs may be lower because of the failure to detect carbon in the sample. Irregular particle shape might also account for differences.

The four samples were also examined by scanning electron microscopy (SEM). SEM photographs of the four samples are shown in Figures 3, 4, 5, and 6. Comparison of the four photographs at a given magnification does not reveal any striking differences. In all of the photographs, most of the particles appear to have rough, angular shapes. There are very few, if any, smooth spheres, suggesting that the ash did not pass through a semi-molten state. This result would be expected from the operating temperature of the TRTU. The roughness of these particles may have implications on PCD performance, because ash cohesivity has been shown to increase with increasing surface roughness of the particles (Bush, et al, 1989; Cushing, et al, 1991). However, all four of the TRTU gasifier samples were found to have relatively low tensile strengths (0.4 to $1.3 \text{ N}/\text{m}^2$), suggesting that the particles may be relatively non-cohesive. The two lowest values of tensile strength (0.4 and $0.8 \text{ N}/\text{m}^2$) were measured on the two samples produced from the Illinois coal, which is the design coal for the HGCTF. These values were lower than all other values of tensile strength contained in the SRI data base.

All four of the TRTU gasifier samples had remarkably high surface areas and morphology factors, suggesting the presence of considerable intraparticle porosity. The measured surface areas and calculated morphology factors are summarized in Table 1.

a

b

c

d

Figure 3. SEM Photographs of Ash from Wyodak Coal
(Taken at Magnifications of 100, 500, 1000, and 5000)

a

b

c

d

Figure 4. SEM Photograph of Ash from Illinois No. 6 Coal, 200- μ m Grind
(Taken at Magnifications of 100, 500, 1000, and 5000)

a

b

c

d

Figure 5. SEM Photograph of Ash from Illinois No. 6 Coal, 50- μ m Grind
(Taken at Magnifications of 100, 500, 1000, and 5000)

Figure 6. SEM Photographs of Ash from Western Kentucky Coal
(Taken at Magnifications of 100, 500, 1000., and 5000)

2.3.4.2 Particulate apparatus and instrumentation.

Work continued on the conceptual design of the particulate sampling system for the HGCTF. Preliminary drawings of the particulate sampling systems and port arrangements were completed this quarter. A preliminary list of equipment needed for the particulate sampling was prepared. Preliminary specifications for all of the listed pieces of equipment were developed. These specifications are being used as a basis for developing a cost estimate for the sampling system. The equipment list and cost estimate will be submitted to SCS in January.

The in situ approach continues to appear to be the most promising approach for the particulate sampling system for Wilsonville. Based on the analysis done to date, the in situ approach appears to be superior to the extractive approach from a technical standpoint, as well as from an economic standpoint. As currently envisioned, the in situ approach would allow placement of an impactor or cyclone into the ducting, with the nozzle at the centerline of the ducting. Depending upon the exact length of the impactor or cyclone, the bottom portion of the sampler may extend into the sampling port. An alkali sorber unit may be connected to the particulate sampler and reside in the port during sampling. The sorber unit would be a cylindrical container filled with activated bauxite or other appropriate sorbent material. Alkali concentration would be determined by extracting the sorbent and analyzing the extract for sodium and potassium using atomic absorption spectroscopy.

General sampling guidelines for the hot gas cleanup test facility were presented previously at the October 22 design review meeting in Wilsonville. These guidelines were also included in the conceptual design document that was issued by SCS in October. The guidelines address the requirements for particulate sampling and evaluation of PCD collection efficiency. Some of the requirements addressed were: locations and types of sampling ports required, valving arrangements and mechanisms required for insertion and removal of sampling probes, requirements for platforms and enclosures, and requirements for automatic data acquisition. These guidelines will be updated as appropriate, and the sampling section of the conceptual design document will be modified accordingly.

The sampling system design is being based on ducting having an internal diameter of 12 inches. Kellogg has agreed to this diameter, after an analysis of the heat loss considerations involved in the expansion from the original diameter of 7 in. This expansion of the ducting was recommended to reduce the gas velocity at the sampling point from 60 ft/sec to about 20 ft/sec, thereby allowing the use of a larger sampling nozzle. The smaller nozzle, which would have been required with the higher gas velocity, would have introduced an unacceptably large potential for generating sampling artifacts. As discussed previously, the sampling system design also assumes that a 10-ft length of straight ducting will be provided ahead of the sampling point.

SRI also began work on a study of the feasibility and requirements for using transmissometry to qualitatively monitor particulate loadings at the inlet and outlet of the PCD and detect fluctuations in PCD performance. A literature search on previous work with transmissometry at high temperature and high pressure was completed. A preliminary layout drawing of the transmissometer ports was also completed.

2.3.4.3 Particulate Control Devices Requests for Proposals

SRI began preparation of a request for proposals (RFP) for the PCDs to be tested at the HGCTF. The RFP includes an explanation of the purpose and general requirements of the RFP; background information on the WHGCTF; the expected PCD operating conditions, gas composition, particle loading, particle composition, and particle characteristics; and the proposal evaluation criteria. The draft prepared by SRI will be supplemented with more detailed information on the WHGCTF design, the scope of supply, and the contractual terms. The detailed design, scope of supply, and contractual information will be supplied by SCS.

3.0 PLANS FOR FUTURE WORK

1. Finalize negotiations with DOE/METC for the TRDU work at UNDEERC and initiate the design of the TRDU.
2. Provide DOE with environmental information on the expanded facility for the NEPA process and initiate the environmental permitting for the expanded facility.
3. Provide DOE with a level-of-effort and cost estimate for the extended conceptual design.
4. Extend the conceptual design for the facility to include the additional modules requested by DOE.
5. Complete the report for the TRTU test runs.

4.0 REFERENCES

- Bush, P.V., T.R. Snyder, and R.L. Chang. *Determination of Baghouse Performance from Coal and Ash Properties: Part I.* J. Air Pollut Control Assoc 39, 228-237 (1989).
- Cushing, K.M., V.H. Belba, R.L. Chang, and T.J. Boyd. *Fabric Filtration Experience Downstream from Atmospheric Fluidized Bed Combustion Boilers.* Presented at the Ninth Particulate Control Symposium. Williamsburg, VA. October 15-18, 1991.
- Dahlin, R.S. and R.F. Altman. *Prediction of Mass Loading and Particle Size Distribution for Use in a Precipitator Sizing Procedure.* In: Proceedings: Conference on Electrostatic Precipitator Technology for Coal-Fired Power Plants. EPRI CS-2908. April 1983, pp. 4-32 to 4-51.
- Dahlin, R.S., J.P. Gooch, and L.Y. Sadler. *Predicting the Particle Size Distribution of Fly Ash.* In: Proceedings: Sixth Symposium on the Transfer and Utilization of Particulate Control Technology. EPRI CS-4918. Volume 1. November 1986, pp. 7-1 to 7-20.
- Flagan, R.C. and S.K. Friedlander. *Particle Formation in Pulverized Coal Combustion - A Review.* In: Recent Developments in Aerosol Science, D.T. Shaw (Ed.), Wiley, New York. 1978, pp. 1227-1237.
- Richardson, C.V. and G.F. Nielsen. *Seam Analyses and Description of U.S. Coal Fields.* In: Keystone Coal Industry Manual, McGraw-Hill, New York. 1981, pp. 525-558.
- Sarofim, A.F., J.B. Howard, and A.S. Padia. *The Physical Transformation of the Mineral Matter in Pulverized Coal Under Simulated Combustion Conditions.* Combustion Science and Technology. 16 187-204 (1977).

**APPENDIX Presentations and Action Items for the 50 Percent Conceptual Design
Review Meeting**

October 29, 1991

TO: Distribution

RE: Hot Gas Cleanup Test Facility for Gasification and Pressurized Combustion
DOE Cooperative Agreement No. DE-FC21-90MC25140
Presentations and Action Items for 50% Conceptual Design Review Meeting

Project Team:

Enclosed is a list of the attendees, the final agenda and a copy of the overheads presented at the 50% Conceptual Design Review Meeting held October 22 at Southern Clean Fuels in Wilsonville, AL. Based on the comments and questions that were discussed during the meeting the following list of action items was derived.

Action Items

1. SCS needs to assemble environmental information from the process release and balance of plant systems to send to DOE to support the NEPA process.
2. SRI needs to coordinate with SCS Engineering on data acquisition requirements for particulate sampling.
3. MWK needs to determine if holdup times for the PCD ash vessels are sufficient at the maximum solids loading for the facility (when only the first cyclone is used).
4. SCS needs to scope out a duct sorbent injection system for operating the facility without limestone.
5. SCS needs to coordinate with MWK and SRI to determine all the interface points for the PCDs.
6. MWK needs to design the blowback gas system for the PCDs at 1,000 to 1,200 psig as suggested by DOE based on the Tidd design.
7. MWK needs to investigate further a gas sampling system that analyzes a broad range of gases for the facility.
8. All comments on MWK scope should be made by the end of October if possible.
9. Bob Bedick (DOE) will check on particulate sampling systems used at the Waltz Mill facility and Mike Epstein (EPRI) will check on particulate sampling methods with EPRI-sponsored programs.

Hot Gas Cleanup Test Facility for Gasification and Pressurized Combustion
DOE Cooperative Agreement No. DE-FC21-90MC25140
Presentations and Action Items for 50% Conceptual Design Review Meeting

10. SCS needs to check the blower discharge pressure and head requirements for the feed hoppers to maintain a continuous 5 psig positive pressure in the hoppers.
11. SRI needs to determine the percent error for sampling particulates at velocities higher than 20 ft/s.

Based on the number of attendees and discussions at the meeting, I feel that we are proceeding down the right path in the design of the test facility. Please contact me at (205) 868-5427 if you have any questions or additional comments.

Sincerely,

A handwritten signature in cursive script, appearing to read "Rodney E. Sears".

Rodney E. Sears
Project Manager

Distribution: Attendees List

MEETING ATTENDANCE RECORD

DATE 10/22/91 CONDUCTED BY _____

Form No. 27

MEETING ATTENDANCE RECORD

DATE _____

DATE 10/22/91 CONDUCTED BY _____

CONDUCTED BY _____

[illegible]

HOT GAS CLEANUP TEST FACILITY FOR GASIFICATION AND PRESSURIZED COMBUSTION

CONCEPTUAL DESIGN STATUS 50% MARK REVIEW MEETING

**OCTOBER 22, 1991
SOUTHERN CLEAN FUELS, WILSONVILLE, AL**

FINAL AGENDA

8:05 - 8:50 AM	Travel to Southern Clean Fuels, Wilsonville
9:00 - 9:30 AM	Introduction and Executive Summary - Rod Sears, SCS
9:30 - 10:00 AM	PCD Issues That Affect the Facility Design - Duane Pontius, SRI
10:00 - 10:30 AM	Design Basis - Tim Pinkston, SCS <ul style="list-style-type: none">- Facility Design Criteria- Blockflow diagram and General Area Descriptions- Facility Design Book Organization
10:30 - 10:45 AM	Break
10:45 - 11:45 AM	Gasifier/Combustor and Hot Gas Stream Design - Jim O'Donnell, P.B. Desai, Bill Ore, MWK <ul style="list-style-type: none">- Process Flow Diagrams and Descriptions- Process Control Diagram and Philosophy- MWK/SCS Interface Points
11:45 - 12:45 PM	Lunch
12:45 - 1:15 PM	Particulate Sampling Requirements - Bill Farthing, SRI
1:15 - 2:15 PM	Balance-of-Plant Design - Randall Kennedy, Bryant Frye, SCS <ul style="list-style-type: none">- Site Layout- Utilities- Materials Handling
2:15 - 3:00 PM	Comments - All
3:00 - 3:15 PM	Break
3:15 - 4:00 PM	Site Tour
4:00 PM	Travel Back to Birmingham

**HOT GAS CLEANUP TEST FACILITY
FOR GASIFICATION AND PRESSURIZED COMBUSTION**

COOPERATIVE AGREEMENT NO. DE-FC21-90MC25140

BETWEEN U.S. DEPARTMENT OF ENERGY/METC AND SOUTHERN COMPANY SERVICES, INC.

50% CONCEPTUAL DESIGN MARK REVIEW MEETING

OCTOBER 22, 1991

SOUTHERN CLEAN FUELS, WILSONVILLE, AL

SOUTHERN COMPANY SERVICES

HOT GAS CLEANUP TEST FACILITY FOR GASIFICATION AND PRESSURIZED COMBUSTION

PROJECT OBJECTIVES:

- **DEVELOP CRITERIA FOR ENGINEERING-SCALE TESTING OF HOT PARTICULATE CLEANUP DEVICES**
- **DESIGN, CONSTRUCT, AND OPERATE HOT GAS CLEANUP TEST FACILITY SIMULATING BOTH FLUIDIZED BED GASIFICATION AND PFBC MODES**
- **TEST PARTICULATE CONTROL DEVICES (PCDs) UNDER REALISTIC CONDITIONS OF GAS COMPOSITION, PRESSURE, TEMPERATURE, PARTICULATE LOADING, OPERATING DURATION, ETC.**
- **INTERPRET AND DISSEMINATE RESULTS TO SUPPORT ONGOING PCD DEVELOPMENT, DEMONSTRATIONS OF HOT GAS CLEANUP TECHNOLOGY, AND SCALE-UP TO COMMERCIAL OPERATION**

PROJECT ORGANIZATION

SOUTHERN COMPANY SERVICES

HOT GAS CLEANUP TEST FACILITY PROJECT MANAGEMENT CHANGES

EFFECTIVE 7/91

OLD MANAGEMENT TEAM

DAVE GALLASPY
BOB HORSLEY
DICK SHAFER
DUANE PONTIUS

NEW MANAGEMENT TEAM

PROJECT MANAGER ROD SEARS
SCS ENG. PROJECT MANAGER RANDALL KENNEDY
MWK PROJECT MANAGER MARTY FANKHANEL
SRI PROJECT MANAGER DUANE PONTIUS

SOUTHERN COMPANY SERVICES

CONCEPTUAL DESIGN TASK SUMMARY

- MUST ADDRESS THE MAJOR DESIGN ISSUES
- EVALUATE TRADEOFFS OF VARIOUS DESIGN CONCEPTS
- TOOL FOR INPUT AND FEEDBACK ON DESIGN BASES
 - DOE/METC
 - EPRI
 - PARTICULATE CONTROL DEVICE VENDORS
- MEANS OF COORDINATION FOR REMAINDER OF THE PROJECT

CONCEPTUAL DESIGN RESPONSIBILITIES

SCS R&EA - SETTING DESIGN BASES, ENVIRONMENTAL PERMITTING

SCS ENGINEERING - COORDINATING ENGINEERING EFFORT, B.O.P. DESIGN

SRI - PCD TECHNOLOGY ISSUES, TESTING REQUIREMENTS

MWK - TRANSPORT REACTOR DESIGN BASES DEVELOPMENT, PROCESS DESIGN

- EXPERIMENTAL PROGRAM
- PROCESS DESIGN ENGINEERING

HOT GAS CLEANUP TEST FACILITY FACILITY DESIGN DOCUMENT

- **PURPOSE: CENTRAL SOURCE OF DESIGN INFORMATION ON THE ENTIRE
FACILITY TO ASSIST THE PROJECT TEAM IN THE DESIGN EFFORT**
- **INTEGRATE INFORMATION FROM VARIOUS MEMBERS OF THE PROJECT TEAM**
- **LIVING DOCUMENT TO BE USED THROUGH END OF DETAILED DESIGN**
- **CONTROLLED DOCUMENT**
 - SCS R&EA WILL MAINTAIN MASTER AND ISSUE REVISIONS
 - PROJECT TEAM SHOULD STRIVE TO KEEP DOCUMENT CURRENT THROUGH SCS
- **TARGET TO SET DOCUMENT ORGANIZATION BY END OF CONCEPTUAL DESIGN**

HOT GAS CLEANUP TEST FACILITY PROJECT STATUS

MAJOR ACTIVITIES TO DATE (10/91)

● CONTRACTING

- MWK AND SRI SUBCONTRACTS COMPLETED
- EPRI PARTICIPATION AGREEMENT IN FINAL NEGOTIATIONS

● INTEGRATION OF PROJECT TEAM

- ENGINEERING SCOPE OF WORK DIVISION AND SCHEDULING
- CHANGE IN PROJECT MANAGEMENT
- FACILITY DESIGN DOCUMENT

● DESIGN BASIS

- PCD ISSUES FOR FACILITY DESIGN ASSESSED
- FACILITY DESIGN BASIS SET
- PROJECT SITE CRITERIA ESTABLISHED
- FLOWSHEET DEFINITION
- TRANSPORT REACTOR DESIGN VERIFICATION TESTING ONGOING
- PROPOSED TRANSPORT REACTOR SCALEUP TESTING AT UND/EEERC

SOUTHERN COMPANY SERVICES

HOT GAS CLEANUP TEST FACILITY PROJECT STATUS

MAJOR ACTIVITIES TO DATE (10/91) - CONTINUED

● CONCEPTUAL DESIGN ACTIVITIES

- SITE RESOURCE AND INTEGRATION ISSUES ASSESSED
- SITE DESIGN DATA, PRELIMINARY SITE AND BUILDING LAYOUTS
- CONCEPTUAL DESIGN PROCESS RELEASE ISSUED
- PRELIMINARY P&IDs AND PROCESS CONTROL DIAGRAM ISSUED
- CONCEPTUAL DESIGN FOR FEED PREPARATION AREA ISSUED
- STARTED DESIGN OF UTILITY SYSTEMS
- APPROXIMATELY AT 50% MARK FOR CONCEPTUAL DESIGN

● ENVIRONMENTAL INFORMATION

- SUPPORT OF NEPA PROCESS
- SOLID WASTE DISPOSAL EVALUATION

HOT GAS CLEANUP TEST FACILITY PROJECT STATUS

SCHEDULE STATUS AND PROJECTION (10/91)

- **SLIPPAGE OF CONCEPTUAL DESIGN COMPLETION BY 6 MONTHS
TO DEC 31, 1991**
- **M. W. KELLOGG SCOPE COMPLETED BY NOV 15**
- **CONCEPTUAL SITE PREP & OPERATION INTEGRATION PLANS DELIVERED
TO DOE BY JAN 31, 1992**
- **FACILITY COST ESTIMATE BY MID-FEB, 1992**
- **START DETAILED DESIGN PHASE IN JAN 1992**
- **OVERLAP OF DETAILED DESIGN AND CONSTRUCTION PHASES TO
MAINTAIN TARGET OPERATION DATE OF JAN 1994
- MAXIMUM OVERLAP IS 6 MONTHS**
- **POTENTIAL EXPANSION OF TEST FACILITY WILL IMPACT SCHEDULE**

Hot Gas Cleanup Test Facility for Gasification and Pressurized Combustion

PCD Issues that Affect Facility Design

Presentation to Southern Company Services
and the U.S. Department of Energy

Prepared by Southern Research Institute

for the Conceptual Design Status Review
(50% Mark)

October 22, 1991
Wilsonville, Alabama

Issues To Be Discussed

1. Type(s) of PCDs selected for evaluation
2. Need to demonstrate long-term durability
3. Variety of on-line cleaning methods
4. Differing requirements for access to PCD
5. Heat loss and temperature drop considerations
6. On-line monitoring requirements

Issues To Be Discussed (Continued)

7. Requirements for extractive sampling
8. Other data acquisition requirements
9. Coal and ash sampling requirements
10. Startup requirements
11. Characteristics of particles from TRTU
12. Others to be identified today or later

Types of PCDs Selected for Evaluation

Candidate PCDs have widely varying characteristics

- Differences in equipment size and weight
- Differences in allowable operating conditions
- Differences in pressure drop characteristics
- Differences in utility requirements

Conceptual design must accommodate entire range of possibilities

Need to Demonstrate Long-Term Durability

**Facility Must Provide Realistic Conditions
for Periods Sufficient to Assess Durability of**

- Ceramic filter elements
- Seals
- Valves
- Ash handling equipment
- Integrated System

PCD Vendors Would Like to See 3000 hrs of Operation

Cleaning Methods

A variety of approaches with differing design implications

Cleaning may be done with air, nitrogen, steam, or process gas

Vendor-specified pressures and flow rates vary widely

Question: Will conceptual design incorporate the process gas option?

Access Requirements for Maintenance and Replacement of Filter Elements

Differences in required clearance and lifting loads may affect

- **Choice of Lifting Facilities (Trolley or Crane)**
- **Locations of Platforms, Stairs, and Ladders**

Heat Loss and Temperature Drop

Aside from the obvious penalty on thermal efficiency, a relatively small temperature drop can also affect particulate properties

- Potential for alkali condensation
- Potential effects on particle cohesion
- Interaction between ash and ceramic filter element

Question: What is maximum acceptable temperature drop across PCD?

Requirements for On-line Monitoring

Potential problems:

- Gradual performance degradation —
 - Increasing pressure drop
 - Decreasing collection efficiency
- Short-term excursions —
 - Filter element failure
 - Process upsets

Points to need for monitoring pressure drop, outlet opacity, and mass loading

Possible need for PCD leak detector (e.g., triboelectric detector)

Requirements for Extractive Sampling

- **Sampling ports (type, location, materials of construction, insulation)**
- **Unobstructed duct runs before and after sampling locations**
- **Special valving arrangements for probe insertion and removal**
- **Platforms, enclosures, and ladders**

These requirements will be discussed in more detail later by Bill Farthing

Other Data Acquisition Requirements

- Flue (fuel) gas flow rate
- Gas temperature and pressure
- Gas composition (possibly including alkalis)
- Coal, air, and steam feed rates

Gas monitoring points should be close to PCDs and PCD sampling points

Coal and Ash Sampling

- **Will be necessary to sample coal, ash, and char during all tests**
- **May be necessary to obtain some samples from pressurized hoppers**
- **May be necessary to maintain certain samples under an inert atmosphere**

Startup Requirements

- **Heat-up rate limited by thermal response of ceramic**
- **Dewpoint excursions must be avoided during cold starts**

Maximum heat-up rate of 200°F/hr recommended by one PCD vendor

Characteristics of Particles Produced by TRTU

Should not differ significantly from those produced by other gas generators

If they do, results might not be transferable to other processes

Characterization of TRTU particles may reveal need to modify process

Could have major effect on facility design

DESIGN BASIS

PCD INLET CONDITIONS

GAS FLOW, ACFM	1000
GAS TEMPERATURE, °F	1000-1800
GAS PRESSURE, PSIA	195
PARTICULATES, PPMW	1000-4000

COAL

TYPE	ILLINOIS #6
% SULFUR, MOISTURE-FREE	3.0
FEEDRATE, #/HR (GASFN)	3166
FEEDRATE, #/HR (COMB)	1232-2278

LIMESTONE

TYPE	LONGVIEW
Ca/S RATIO, MOLAR	1.5
FEEDRATE, #/HR (GASFN)	433
FEEDRATE, #/HR (COMB)	169-312

PLANT MATERIAL BALANCE
(GASIFICATION CASE)

#/HR

INPUT

COAL	3166
LIMESTONE	433
GASIFICATION AIR	11421
AIR TO OXIDIZER	19414
AIR TO SULFATOR	3929
BFW	35489
QUENCH WATER	3894
LPG	175
 TOTAL IN	 77921

OUTPUT

WASTE SOLIDS	751
STEAM	33703
BLOWDOWN	710
FLUE GAS	38772
SULFATOR GAS	3985
 TOTAL OUT	 77921

PLANT MATERIAL BALANCE
(COMBUSTION CASE)

#/HR

INPUT

COAL	2278
LIMESTONE	312
COMBUSTION AIR	23103
BFW	31638
QUENCH WATER	1510
 TOTAL IN	 58841

OUTPUT

WASTE SOLIDS	548
STEAM	31006
BLOWDOWN	633
FLUE GAS	26654
 TOTAL OUT	 58841

WILSONVILLE HOT GAS CLEANUP TEST FACILITY

MWK Job No. 8784
Oct. '91

FEED/REACTOR SYSTEMS

MMK Job No. 6704
Oct. '91

REACTOR/SOLIDS SYSTEMS

MWK Job No. 6734
Oct. '91

GAS COOLER/PCD SYSTEMS

GAS COOLER

PCD/GAS COOLER SYSTEMS

THERMAL OXIDIZER SYSTEM

SULFATION SYSTEM

ANCHOR POINTS FOR PROCESS CONTROL

- COAL FEED RATE
- LIME FEED RATE
- REACTOR TEMPERATURE CONTROL
- PCD INLET PRESSURE CONTROL
- DISENGAGER SOLIDS LEVEL CONTROL

SIMPLIFIED CONTROL CONCEPT

100

AREA - 200 (REACTOR)

The diagram illustrates a process flow for gas-solids separation. The main components and their connections are as follows:

- Feed Inlet:** A line labeled "FROM 202-C" enters the system, passing through a valve and a "R.O." (Restricting Orifice) before entering the main process line.
- Process Line:** The main horizontal line contains two heat exchangers, labeled "402-C" and "406-C", connected in series. A "PIC" (Process Indicator Controller) is connected to the line between these two heat exchangers. A "TI" (Temperature Indicator) is also connected to this line.
- Gas Analysis:** A "GAS ANALY." (Gas Analyzer) is connected to the process line between the two heat exchangers. It has a "FI" (Flow Indicator) on its inlet and an "AI" (Analyzer Indicator) on its outlet.
- Blowback Gas:** A line labeled "BLOWBACK GAS FROM 402-J" enters the process line between the two heat exchangers.
- Heat Recovery:** A line labeled "TO 401-B or 403-J" exits the process line after the "402-C" heat exchanger, passing through a valve.
- Solids Separation:** The process line enters a vertical vessel labeled "302-L" (Solids Separator). The vessel has a "TI" (Temperature Indicator) on its side. The bottom of the vessel is connected to a line that splits into two paths, each leading to a valve and then to a "SOLIDS TO 501-F" outlet.
- Control and Monitoring:** A "PI" (Pressure Indicator) is connected to the process line between the two heat exchangers. A "TI" (Temperature Indicator) is connected to the process line after the "406-C" heat exchanger. A "PI" (Pressure Indicator) is connected to the process line before the "302-L" vessel.

AREA - 400

AREA - 500

AREA - 600

ANAYLZERS

- **MASS SPECTROMETER**

- SAMPLE CONDITIONING SYSTEM REQUIRED

- COMPONENTS

- ANALYSIS POINT A1

- **OXYGEN ANALYZERS**

- INSITU ANALYZERS

- AUTO CALIBRATION

- ANALYSIS POINT A2

- **DENSITY ANALYZERS**

- INLINE MEASUREMENT

- ANALYSIS POINT A3

- **CONDUCTIVITY ANALYZERS**

- ANALYSIS POINT A4

- **PARTICULATE ANALYZER BY SCR**

MWK/SCS INTERFACE

- DESIGN BASIS DOCUMENT
- AREA INTERFACE
- ENGINEERING DESIGN INTERFACE

AREAS WITHIN MWK SCOPE OF WORK

- AREA 200 GAS GENERATOR
- AREA 300 PARTICULATE CONTROL DEVICES
- AREA 400 GAS COOLING AND TREATMENT (PARTIAL)
- AREA 500 ASH HANDLING (PARTIAL)
- AREA 600 SULFATOR

MWK Job No. 6704
Oct. '91

MWK/SCS AREA INTERFACES

- AREA 100 FEED PREPARATION
- AREA 500 ASH HANDLING
- AREA 600 SULFATOR
- AREA 1000 INSTRUMENTATION & DATA ACQUISITION
- AREA 2000 UTILITIES
- AREA 3000 ELECTRICAL

MWK/SCS ENGINEERING DESIGN INTERFACE

- STRUCTURAL

- UTILITIES

- ELECTRICAL

- INSTRUMENTATION

- FEED

- GAS TREATMENT

- SOLIDS DISPOSAL

- PCD REQUIREMENTS

1.3 SAMPLING SYSTEM PIPING AND COMPONENTS

1.3.1 PRESSURE BOUNDARY PIPING - ASME b.31.3

PRESSURE VESSELS - ASME VIII DIV 1

1.3.2 EXTRACTIVE SAMPLE SYSTEM REQUIREMENTS

- a) Interface with process pipe allowing sample probe insertion.
- b) Double isolation and purge valve heated to maintain sample temperature - also must have bore to match probe internal diameter.
- c) Cyclone, impactor heated to maintain sample temperature.
- d) Removal of cyclone, impactor to readily allow sample analysis.
- e) Cyclone, impactor vessels are pressure boundary, ASME VIII OR ASME B31.3.

1.3.3 IN-SITU SAMPLING SYSTEM REQUIREMENTS

- a) Determination of enclosure pipe diameter and length required to allow use of existing valves and fittings qualified for approximately 800°F service.
- b) Calculation of cyclone train downstream temperatures.
- c) Development of sampling pipe packing gland allowing withdrawal prior to first valve closure.

1.3.4 OPERATIONAL REQUIREMENTS

- a) Efficient removal and installation of cyclone, impactor for analysis while facility is in operation.
- b) Double isolation of process gas.
- c) Maximum life of cyclone, impactor and associated hardware (valves, heaters, flow controls, instrumentation).

1.3.5 STRUCTURAL, MECHANICAL, ELECTRICAL INTERFACES

- a) Sampling system supports, hangers for thermal and dead load - SRI to provide configuration and component weights to SCS.
- b) Sampling system man platforms for routine probe or cyclone removal - overhead trolley.
- c) Nitrogen supply to sampling system. Waste gas vent header connection for used sample gas, vessel relief valve.
- d) Electrical heater 220 vac supply.
- e) Sampling lab facility.

HOT GAS CLEANUP TEST FACILITY
WILSONVILLE, ALABAMA

1.0 PARTICULATE SAMPLING SYSTEM DESIGN PROCESS CONSIDERATIONS
SOUTHERN RESEARCH INSTITUTE

1.1 MATERIALS OF CONSTRUCTION

DESIGN CONDITIONS - - 1800°F. 300 PSI

REDUCING, OXIDIZING, SULFIDIZING ATMOSPHERES

1.2 CYCLONE, IMPACTOR MATERIALS

1.2.1 NON-PRESSURE BOUNDARY, NON CODE

1.2.2 CANDIDATE MATERIALS

- a) Incoloy 800, 671
- b) Haynes 430, 230
- c) Machineable ceramics
- d) Coated graphite composite
- e) Stainless steel

1.2.3 PROTECTIVE COATINGS/GASKET MATERIALS

- a) Deposited metal alloys
- b) Ceramic coatings
- c) Graphite, metal, mineral gaskets

INERTIAL IMPACTORS

STOKES NUMBER FOR 50% COLLECTION EFFICIENCY = STk_{50}

$$STk_{50} = \frac{2D_{50}^2 Q}{9\pi\mu W^3}$$

where

D_{50} = Particle Impaction Diameter - 50% Collection Efficiency

Q = Flowrate

μ = Viscosity

W = Jet Diameter

Figure 2. Penetration (without deposition) of particles through the extraction probe versus particle diameter over a range of sampling rates.

FIVE-STAGE CYCLONE SYSTEM

Figure 1. PCD and Duct Layout Showing Proposed Sampling Port Locations

Figure 2. Side View of Inlet Sampling Duct and Alternate Port and Sampler Configurations

Main duct and insulation

Cyclone train

Main duct and insulation

Cyclone train

Figure B-1. Schematics of six commercial cascade impactors (Sheet 2 of 3).

Figure 2. Penetration (without deposition) of particles through the extraction probe versus particle diameter over a range of sampling rates.

HOT GAS CLEANUP TEST FACILITY
WILSONVILLE, ALABAMA

1.0 PARTICULATE SAMPLING SYSTEM DESIGN PROCESS CONSIDERATIONS
SOUTHERN RESEARCH INSTITUTE

1.1 MATERIALS OF CONSTRUCTION

DESIGN CONDITIONS - - 1800°F. 300 PSI

REDUCING, OXIDIZING, SULFIDIZING ATMOSPHERES

1.2 CYCLONE, IMPACTOR MATERIALS

1.2.1 NON-PRESSURE BOUNDARY, NON CODE

1.2.2 CANDIDATE MATERIALS

- a) Incoloy 800, 671
- b) Haynes 430, 230
- c) Machineable ceramics
- d) Coated graphite composite
- e) Stainless steel

1.2.3 PROTECTIVE COATINGS/GASKET MATERIALS

- a) Deposited metal alloys
- b) Ceramic coatings
- c) Graphite, metal, mineral gaskets

1.3 SAMPLING SYSTEM PIPING AND COMPONENTS

1.3.1 PRESSURE BOUNDARY PIPING - ASME b.31.3

PRESSURE VESSELS - ASME VIII DIV 1

1.3.2 EXTRACTIVE SAMPLE SYSTEM REQUIREMENTS

- a) Interface with process pipe allowing sample probe insertion.
- b) Double isolation and purge valve heated to maintain sample temperature - also must have bore to match probe internal diameter.
- c) Cyclone, impactor heated to maintain sample temperature.
- d) Removal of cyclone, impactor to readily allow sample analysis.
- e) Cyclone, impactor vessels are pressure boundary, ASME VIII OR ASME B31.3.

1.3.3 IN-SITU SAMPLING SYSTEM REQUIREMENTS

- a) Determination of enclosure pipe diameter and length required to allow use of existing valves and fittings qualified for approximately 800°F service.
- b) Calculation of cyclone train downstream temperatures.
- c) Development of sampling pipe packing gland allowing withdrawal prior to first valve closure.

1.3.4 OPERATIONAL REQUIREMENTS

- a) Efficient removal and installation of cyclone, impactor for analysis while facility is in operation.
- b) Double isolation of process gas.
- c) Maximum life of cyclone, impactor and associated hardware (valves, heaters, flow controls, instrumentation).

1.3.5 STRUCTURAL. MECHANICAL. ELECTRICAL INTERFACES

- a) Sampling system supports, hangers for thermal and dead load - SRI to provide configuration and component weights to SCS.
- b) Sampling system man platforms for routine probe or cyclone removal - overhead trolley.
- c) Nitrogen supply to sampling system. Waste gas vent header connection for used sample gas, vessel relief valve.
- d) Electrical heater 220 vac supply.
- e) Sampling lab facility.

4.0 SITE LAYOUT

The HGCTF will be located at the Southern Company's Clean Coal Research Center (CCRC) in Wilsonville, Alabama. The CCRC is located adjacent to Alabama Power Company's Plant Gaston. Figure 3-1 is an aerial photograph showing the location of the existing facilities and the site for the HGCTF.

The location of the facility at this site will allow various utilities to be shared with the existing facilities. An assessment of the utilities to be shared and a determination of the interface points will be completed as part of the facility conceptual design.

4.1 SITE SELECTION

Existing property maps, topographic maps and aerial photographs of the land adjacent to the existing project sites at Wilsonville were reviewed for proposed siting. Recent construction of railroad facilities on the property made much of the information available from existing topographic maps obsolete. Land available for project use is limited by the proximity of existing railroad lines, existing plant facilities and high voltage transmission lines. Based on field walkdowns and preliminary mapping, three potential site locations were selected for preliminary consideration. Selection of the site shown on drawing E-C-P002 Site Development Plan was based on plant access, site preparation costs and anticipated future land usage of the remaining property.

4.2 SITE DEVELOPMENT

After preliminary selection of a proposed site, a detailed topographic survey, core hole drilling and soil investigation was conducted by Alabama Power Company Field Service personnel. Evaluation of core hole data and soil testing indicated that existing site conditions would adequately support the various types of structural foundations intended for the site. A layout of the various plant structures shown on drawing E-C-P001 Plant Arrangement was then prepared using the following criteria: individual building size dictated by technical requirements and function, clearance around buildings required by function, access and future use, plant access, proximity of existing facilities for shared utilities, physical site size limitations, and extra space requirements for future plant expansion. A stepped site layout was considered to make the best use of the land profile and to reduce site excavation cost; however, a completely flat site was determined to be more compatible with any necessary future plant expansions and convenience of use.

DEPARTMENT OF ENERGY
NIDOLVILLE HOT GAS CLEAN-UP
TEST FACILITY
ENTRANCE ROAD LAYOUT
PLAN & PROFILE

DEPARTMENT OF ENERGY
WABCONVILLE HOT GAS CLEANUP
TEST FACILITY
PLANT ARRANGEMENT

ADMINISTRATIVE/SERVICE BUILDING LAYOUT

The conceptual layout of the Administrative/Service Building is shown on drawing E-C-P005 and includes the following scope items:

- o One manager's office (15' x 12')
- o Five supervisors' offices (10' x 12')
- o Research personnel office (11' x 12')
- o Shift supervisor's office adjacent to control room, 4 desks (12' x 17')
- o Data acquisition room (9' x 12) adjacent to control room
- o Reception area for 2 secretaries
- o Copy/Fax room (8' x 12') adjacent to reception area
- o Engineering Department room, 6 cubicle offices, plus area for 3 desk workstations
- o Large conference room (27' x 15') and small conference room (12' x 12')
- o Break room and locker rooms, size for 38 day-shift personnel plus 3 other shifts with 9 workers per shift---total O&M personnel: 65
- o Small restroom for visitors adjacent to reception area
- o Chemical lab (30' x 29'), 3 work stations, 2 lab benches, 2 sinks, hood exhaust, chemical lab supervisor's office adjacent to lab
- o Control room (29' x 29') and equipment room (31' x 22') will front process structure
- o Breakroom (24' x 12')
- o Janitorial service closet with sink
- o Building is prefab metal structure approximately 9,200 sq. ft. in area

WAREHOUSE/MAINTENANCE SHOP LAYOUT

The conceptual layout of the Warehouse/Maintenance Shop is shown on drawing E-C-P005 and includes the following scope items:

- o Maintenance Shop full building width with 20' ceiling (37.5' x 60')
- o Maintenance supervisor's office (10' x 10')
- o Roll-up door at each end
- o Instrument air clean room (10' x 10')
- o Maintenance Shop sized for welding station with screen, pipe thread area, work bench, drill press, lathe, material rack and sink
- o Men's and women's restrooms
- o Warehouse full building width with 20' ceiling (37.5' x 60')
- o Recessed loading dock with roll-up doors at each end of warehouse
- o Mezzanine floor at EL. + 10.0' (12' x 30')
- o Fenced storage (25' x 60') with 10' gate
- o Interior firewall will separate warehouse area from maintenance shop area
- o Building is prefab metal structure approximately 4,500 sq. ft. in area

FLOOR PLAN
SCALE: 1/8" = 1' - 0"

ADMINISTRATIVE BUILDING
EAVE HEIGHT 14'-0"
SQ. FOOTAGE 9200

WAREHOUSE/MAINTENANCE SHOP
EAVE HEIGHT 24'-0"
SQ. FOOTAGE 4700

FLOOR PLAN
SCALE: 1/8" = 1'-0"

END DATE
9-14-92