

HIGH BTU GASIFICATION ENVIRONMENTAL ASSESSMENT - WORK STATUS AND PLANS

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Abstract

This recently initiated 3-year study is aimed at environmental assessment of high-Btu coal gasification including identification of the control technology needs for the industry. The effort consists of: (a) evaluation of existing process and environmental data and the data which are being generated by other EPA/ERDA contractors working in related areas; (b) acquisition of supplementary data through sampling and analysis of process/waste streams at selected gasification facilities; and (c) environmental assessment and necessary process engineering support studies.

The program activities fall into three work areas: Environmental Assessment, (Field) Data Acquisition, and General Program Support. The work areas are broken down into a total of 17 interrelated tasks. To provide program flexibility, a "work package" approach is used by EPA to authorize work relevant to specific tasks in the program. A total of nine Technical Directives have been issued by EPA authorizing work relevant to 10 tasks.

Most of the effort in the program to date has been in connection with two technical directives, Acquisition and Analysis of the Data Base, and Site Locations and Information. A large number of pertinent background documents have been acquired. Nine gasification processes have been selected for detailed analysis. A "modular" approach has been chosen for analysis and presentation of data on gasification, gas treatment, pollution control, and integrated facilities. Draft "gasification data sheets" have been prepared for six of the nine processes considered. Preliminary discussions have been held with

ERDA and a number of private process developers to enlist their cooperation in identifying potential sites for environmental sampling and in arranging for such sampling.

INTRODUCTION

Under a contract awarded to TRW in May 1977 by EPA/IERL-RTP, TRW is currently working on a 3-year program to (a) characterize the waste streams associated with the operation of commercial high-Btu gasification facilities using current and developmental conversion technologies, (b) identify the control technology required to reduce or eliminate waste discharges, and (c) estimate the environmental impacts at selected sites. The study will provide input to the EPA effort for developing and demonstrating control technologies for emerging industries and for establishing the technical basis for drafting new source performance standards for gasification plants.

Because the program has only been started very recently, sufficient results are not available for presentation at this time. This paper will present a description of the program in terms of its structure and the mechanism by which tasks in the program are initiated. The objectives of and the preliminary accomplishments in the few tasks that have been initiated will also be reviewed.

GENERAL STUDY APPROACH AND WORK BREAKDOWN STRUCTURE

The technical approach for achieving the program objectives consists of the following activities:

1. Generation of a gasification/gas upgrading, control technology, and impact assessment baseline.
2. Definition of information gaps and deficiencies and areas for productive application of engineering analysis.
3. Conduct of field sampling and analysis programs aimed at filling data gaps and providing needed information.
4. Conduct of selected engineering analyses to supplement available process and control equipment information.

5. Integration of all information and data into assessment and technology overview documents.

For planning purposes and to provide for effective program management, the program has been divided into three work areas: Work Area A, Environmental Assessment; Work Area B, Data Acquisitions; and Work Area C, General Program Support. A brief description of the activities in and the specific objectives of each work area follows.

Work Area A - Environmental Assessment

The overall objective of Work Area A is to assess the environmental impacts associated with commercial-scale high-Btu gasification operations. The environmental assessment will be based upon (a) review of the published literature on gasification processes and related control technologies; (b) data which are being generated by other EPA contractors working in related areas (e.g., low/medium Btu gasification environmental assessment; coal liquefaction environmental assessment, etc.); (c) data to be acquired from process developers and government agencies; and (d) data to be generated in Work Area B through environmental sampling at high-Btu gasification sites, in Work Area A through process engineering, and in Work Area C through support studies. More specifically, the efforts in and the objectives of Work Area A are as follows:

- Evaluation of available data relative to gasification, gas processing technology and economics, input material characteristics, current control technologies, and process/equipment environmental characteristics.
- Preparation of a technology overview document.
- Prioritization, in order of projected commercial viability, of gasification processes.
- Identification and prioritization of emissions data and information gaps.
- Evaluation of the potential of developmental control technologies.
- Process engineering studies to aid in evaluation of data validity; resolution of data conflicts and filling data gaps.
- Integration of the Work Area B data in-

to technology overview and impact assessment documents.

- Projection, on a common production basis, of the impact data base to commercial scale.

To accomplish the above-listed objectives, and for planning purposes, Work Area A has been subdivided into a total of nine interrelated tasks. A listing and brief description of these tasks are presented in Table 1.

Work Area B - Data Acquisitions

To be meaningful and technically valid, the environmental assessment of high-Btu gasification should be based, as far as practicable, on actual process and emissions data for existing commercial and pilot plant facilities. Since only a limited amount of such data is currently available, in the present program considerable emphasis is placed on data acquisitions through comprehensive environmental sampling and analysis at selected pilot plant/commercial facilities. Reflecting this emphasis and for planning purposes, about 40 percent of the program funds and manpower has been earmarked for data acquisitions. The sampling and analysis program will be aimed primarily at generating data to fill some of the gaps identified in Work Area A. More specifically Work Area B involves the following activities, objectives:

- Identification of representative candidate high-Btu gasification process, gas cleaning and upgrading sampling sites, and assessment of the likelihood of gaining access to these sites for sampling purposes.
- Ranking of candidate sites, based upon operator cooperation, process stage of development, and other factors.
- Organization, cost and planning of the field and laboratory sampling, and analysis efforts associated with each selected site.
- Implementation of field and laboratory data acquisition programs at the selected sites.

To accomplish the above-listed objectives in an orderly manner, Work Area B has been sub-

TABLE 1
WORK AREA A TASK DESCRIPTIONS

Task	Description
A1 - Technology Overviews	Overview report on status and technical/ environmental aspects of gasification processes.
A2 - Impact Assessments	Preliminary impact assessments to identify data needs.
A3 - Input Material Characterizations	Review of physical/chemical characteristics of process input materials.
A4 - Process Engineering	Material/energy balances and other engineering analyses to characterize integrated facilities, resolve data conflicts and verify data accuracy.
A5 - Control Technology Evaluation	Review of pollution control technologies applicable to gasification.
A6 - Accidental and Transient Pollutant Releases	Identification of potential sources and nature and quantities of pollutant emissions during accidents and transient operations.
A7 - New Control Technology	Conceptual designs of applicable new control technologies and in-plant changes, and/or modifications of existing control technologies.
A8 - Revised Impact Assessments	Detailed environmental assessment incorporating the data generated in the program.
A9 - Revised Technology Overviews	Updated technology overviews, incorporating additional data and findings.

divided into a total of six tasks as described in Table 2.

Work Area C - General Program Support

Major activities in Work Area C include: (a) collection and maintenance of background data on the technology and environmental aspects of high-Btu gasification including preparation and periodic updating of an "analysis of the data base" document; (b) performance of miscellaneous document reviews, surveys and special studies on an as required basis to support program activities in Work Areas A and B; and (c) providing program management and control functions, including reporting to EPA and coordination with other EPA contractors working in related areas. For planning purposes, Work Area C has been subdivided into three tasks described in Table 3.

Work Authorization Via Technical Directives

To provide maximum program flexibility and to accommodate changes in program emphasis which may become necessary as the program proceeds, a "work package" approach is used by EPA to authorize work in a specific task or elements of one or more tasks. The scope of the effort in each work package, the funding level and the performance period are specified in work authorization "Technical Directives" (TD's) which are issued by the EPA Project Officer. To date, a total of nine TD's have been received authorizing work relevant to Tasks 1 through 5 in Work Area A; Tasks 1 and 2 in Work Area B; and Tasks 1, 2, and 3 in Work Area C (see Tables 1, 2, and 3 for task descriptions.) These TD's, the relevant tasks covered, the TD issue dates, and performance periods are listed in Table 4.

TABLE 2
WORK AREA B TASK DESCRIPTIONS

Task	Description
B1 - Site Locations and Information	Identification of potential domestic and foreign test sites and establishment of initial contacts.
B2 - Data Possibilities	Test site screening and prioritization and identification of sampling opportunities.
B3 - Test Program Development	Preparation of detailed sampling plan for Level 1 environmental assessment for selected sites.
B4 - Cost Estimates	Estimation of sampling/analysis costs.
B5 - Testing	Field testing and laboratory analyses.
B6 - Data Analysis and Reporting	Reduction and evaluation of the test data.

TABLE 3
WORK AREA C TASK DESCRIPTIONS

Task	Description
C1 - Background and Evaluations	Collection and evaluation of background engineering/environmental data, and identification of data gaps and conflicts; special studies/surveys in support of program activities.
C2 - Reporting and Coordination	Preparation of reports and coordination with EPA, EPA contractors and other agencies.
C3 - Program Management	Program management including financial control.

TABLE 4
TECHNICAL DIRECTIVES, RELEVANT TASKS, ISSUE DATES,
AND PERFORMANCE PERIODS

TD #	Title	Relevant Task(s)*	Date Issued	Performance Period
001	Work Plan Preparation and Coordination	C-2	5-3-77	5 mo.
002	Acquisition and Analysis of the Data Base	C-1	6-22-77	6 mo.
003	Technology Overview Process Engineering	A-1 A-4	6-22-77	6 mo.
004	Site Locations and Information	B-1	6-22-77	7 mo.
005	Program Management, Coordination, and Reporting	C-3 C-2	6-22-77	6 mo.
006	Applicability of Petroleum Refining Control to Gasification and Other Synfuel Processes	A-5	7-18-77	7 mo
007	Data Possibilities	B-2	8-23-77	9 mo.
008	Preliminary Impact Assessment Input Material Characterization	A-2 A-3	8-23-77	3 mo.
009	Review and Evaluation	C-1	8-25-77	6 mo.

*See Tables 1, 2, and 3 for task descriptions

STATUS OF WORK AUTHORIZED UNDER TECHNICAL DIRECTIVES

The work authorized under TD 001 has now been completed. The effort consisted of preparation of a work plan and initial coordination with other EPA contractors by attending an "all-contractors" meeting. TD 002 and TD 004 will be discussed in more detail below. TD 003 authorizes the preparation of a Technology Overview Report (Task A-1, see Table 1) and the conduct of necessary process engineering studies to support activities authorized under other TD's. Since the Technology Overview Report will be based upon the data base being developed under TD 002, the preparation of this document has been intentionally delayed until significant progress is made in connection with the acquisition and analysis of the data base (TD 002). Because the program has been started only recently, there has been little need to date for process engineering support activities.

However, as the work progresses, there will be an increased demand for process engineering support. The work performed under TD 005 has been primarily concerned with program management including reporting to and coordination with EPA.

Many of the control technologies which have been developed for use in petroleum refining would be applicable (in certain cases with some modification) to the synfuel processes. TD 006 authorizes a detailed evaluation of such applicability as part of the control technology evaluation effort in Task A-5. As indicated in Table 4, TD 006 has been issued only very recently. The limited work which has been carried out under this TD consists of collection and review of pertinent key documents on refinery waste/process streams and control technologies.

TD 007, TD 008, and TD 009 have just been issued; the work authorized under these TD's has been restricted to planning activities. Most of the effort in the program to date has been in

connection with TD 002, Acquisition and Analysis of the Data Base, and TD 004, Site Locations and Information. Brief descriptions of the accomplishment under these two TD's follow.

TD 002, Acquisition and Analysis of the Data Base.

The acquisition and analysis of the data base are considered the first steps toward detailed environmental assessment of high-Btu gasification. The overall objectives of the effort are to identify the gaps which exist in the available data and the additional data needed for detailed environmental assessment. The activities which have been carried out under TD 002 fall into two categories: data base development and data analysis.

The data base development effort has consisted of identification and acquisition of pertinent documents and establishment of a centralized "high-Btu gasification library" for use by the project personnel. The current library holdings stand at 415 documents consisting primarily of EPA/ERDA reports, symposium proceedings, and journal articles. A system of key word indexing has been developed and used in a computer program which permits easy information retrieval.

Nine gasification systems have been selected as the minimum for detailed analysis in this program. These are Hygas, Bigas, Cogas, Hydrane, Synthane, Texaco, CO₂-Acceptor, Self-agglomerating Ash, and Lurgi. A "modular" approach has been selected for evaluation and presentation of information on these processes. The "modules" which will be addressed are "gasification module," "gas treatment module," "pollution control module," and "integrated facilities." A "data sheet" outline (see Table 5) has been drafted for the presentation of information on the gasification module. Separate "data sheet" outlines are being prepared for the presentation of information on gas purification, pollution control, and integrated facility modules. The use of the data sheet format, which omits lengthy and general process descriptions, is believed to be an excellent means for presentation of key information items, imparting high "visibility" to the engineering "facts and

figures," allowing ready comparison of different processes, and underlining areas where significant gaps exist in the available data. The first draft of the gasification data sheet has been completed for six of the nine processes considered (Synthane, Texaco, CO₂-Acceptor, Lurgi, Cogas, and Hydrane). These draft sheets will be updated and revised as more data become available to the program. To assure the accuracy and completeness of the information, it is planned to forward these data sheets to the process developers (ERDA, Texaco Development Company, American Lurgi, and CONOCO) for review and comments.

TD 004, Site Locations, and Information.

As was indicated above, because of the heretofore lack of extensive environmental data on high-Btu gasification processes, the present program places a very strong emphasis on data acquisition through environmental sampling at gasification sites. Obtaining access to a significant number of "important" sites is considered the key to the success of the program. Since six of the nine gasification processes considered are ERDA processes which are being or have been tested at domestic sites, a concentrated effort is currently being directed at exploring sampling opportunities at the ERDA sites. A preliminary meeting has been held with ERDA in Washington to enlist that agency's support for the program. Two possibilities for sampling are being explored: (a) independent sampling at gasification sites and (b) where applicable, "piggybacking" existing and/or planned ERDA environmental sampling and assessment programs (e.g., in connection with Synthane and Bigas Processes). Sampling opportunities at several overseas commercial gasification sites and at one domestic facility operated by a private developer are also currently being explored. Even though the gasification operations at some of these facilities (e.g., the Modderfontein plant in South Africa which uses the Kopper-Totzek Process) result in the production of low-medium Btu gas, these plants have features and processing steps similar to those employed in the production of high-Btu gas.

In connection with TD 004 and in conjunction with the efforts which are or will be carried

TABLE 5
OUTLINE FOR GASIFICATION OPERATIONS DATA SHEET

<p>1.0 GENERAL INFORMATION</p> <p>1.1 Operating Principles</p> <p>1.2 Development Status</p> <p>1.3 Licensor/Developer</p> <p>1.4 Commercial Applications</p> <p>2.0 PROCESS INFORMATION</p> <p>2.1 Bench-Scale/Process Development Unit (Figure, Flow Diagram)</p> <p>2.1.1 Gasifier</p> <p style="padding-left: 20px;">Equipment</p> <ul style="list-style-type: none"> - Construction - Dimensions - Bed type and gas flow - Heat transfer and cooling - Coal feeding - Gasification media introduction - Ash removal - Special features <p style="padding-left: 20px;">Operating Parameters</p> <ul style="list-style-type: none"> - Gas outlet temperature - Coal bed temperature - Gasifier pressure - Coal residence time in gasifier <p style="padding-left: 20px;">Raw Material Requirements</p> <ul style="list-style-type: none"> - Coal feedstock <ul style="list-style-type: none"> Type Size Rate - Coal pretreatment - Stream - O₂/air - Other materials <p style="padding-left: 20px;">Utility Requirements</p> <ul style="list-style-type: none"> - Water <ul style="list-style-type: none"> Boiler Quench Cooling - Electricity <p style="padding-left: 20px;">Process Efficiency</p> <ul style="list-style-type: none"> - Cold gas efficiency - Overall thermal efficiency 	<p>Expected Turndown Ratio</p> <p>Gas Production Rate/Yield</p> <p>2.1.2 Coal Feed/Pretreatment</p> <p>2.1.3 Quench and Dust Removal</p> <p>2.1.4 Miscellaneous Operations</p> <p>2.2 Pilot Plant (Figure, Flow Diagram) (Subheadings same as under 2.1 above)</p> <p>2.3 Demonstration/Commercial Facilities (Subheadings same as under 2.1 above)</p> <p>3.0 PROCESS ECONOMICS</p> <p>4.0 PROCESS ADVANTAGES</p> <p>5.0 PROCESS LIMITATIONS</p> <p>6.0 INPUT STREAMS</p> <p>6.1 Coal</p> <ul style="list-style-type: none"> - Type/origin - Size - Rate - Composition <ul style="list-style-type: none"> Moisture Volatile matter Ash C, etc. Minor and trace elements - HHV (dry) - Swelling number - Caking index <p>6.2 Steam (temperature and pressure)</p> <p>6.3 Oxygen/Air</p> <p>6.4 Other Inputs (properties and composition)</p> <p>7.0 DISCHARGE STREAMS (including unit production rates)</p> <p>7.1 Gaseous</p> <ul style="list-style-type: none"> - Stream (x): product gas - Stream (y), etc. <p>7.2 Liquid</p> <p>7.3 Solid</p> <p>8.0 DATA GAPS AND LIMITATIONS</p> <p>9.0 RELATED PROGRAMS</p> <p>REFERENCES</p> <hr/>
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out under TD 002 (Acquisition and Analysis of the Data Base) and TD 007 (Data Possibilities), information is being collected on the plant flow

diagram, waste/process stream accessibility, operating conditions, schedule, etc., for the candidate gasification test sites.