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DEVELOPMENT OF A DATABASE MANAGEMENT SYSTEM FOR COAL COMBUSTION BY-PRODUCTS (CCBs)

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Abstract

Coal combustion by-products (CCBs) are produced in high volumes worldwide. Utilization of these materials is economically and environmentally advantageous and is expected to increase as disposal costs increase. The American Coal Ash Association (ACAA) is developing a database to contain characterization and utilization information on CCBs. This database will provide information for use by managers, marketers, operations personnel, and researchers that will aid in their decision making and long-term planning for issues related to CCBs. The comprehensive nature of the database and the interactive user application will enable ACAA members to efficiently and economically access a wealth of data on CCBs and will promote the technically sound, environmentally safe, and commercially competitive use of CCBs.

Introduction

Understanding the mechanisms involved in the formation and utilization of coal combustion by-products (CCBs) is a time-consuming and expensive task of compiling, processing, manipulating, and relating data. To assist its members in managing coal by-products in a cost-effective manner, the American Coal Ash Association (ACAA) is developing a database management system. The database will be unique in that it incorporates information on fuel source, burning conditions, collection and storage methods, and analytical results, allowing the user to assess interactions between sample generation and ash properties. Bringing together ACAA member resources in a coordinated, practical database will allow members to better understand the behavior of CCBs. The user-friendly application provides point-and-click browsing of data and quickly transforms raw data into reports and graphs. ACAA members will have ready access to the kinds of information most often needed for decisions related to the production and utilization of CCBs.

ACAA has contracted with the Energy & Environmental Research Center (EERC) to develop the database management system. The EERC has established a database on characterization of CCBs through a consortium of industry and government members, scientists, and engineers called the Coal Ash Resources Research Consortium (CARRC, pronounced "cars"). What began as a simple collection of information on physical, chemical, and mineralogical characteristics of coal ashes has expanded to form a database of information on more than 800 coal fly ash samples, called the Coal Ash Properties Database (CAPD). Data from the CAPD will be included in the ACAA database.

Overview of the Database Management System

The database management system (DBMS) comprises two separate pieces of software installed as one package: the database engine and the database application. The engine (Sybase SQL Anywhere, Version 5.0.02©, Sybase, Inc.) manages all of the data stored in the database. It provides for the storage, manipulation, and integrity of the data. The application allows users to access the database in a user-friendly format (PowerBuilder, Version.5.0.01©, Sybase, Inc) . The application communicates with the engine through structured-query language (SQL), which has been coded into the design of the application. The SQL statements fetch data from the engine and return them to the application, where data manipulation and processing continue.

There are several advantages to keeping the engine and the application separate. Since the engine does not depend upon the application and vice versa, updates can be applied separately. For example, as new data are added to the database, the database portion of the system can be distributed to the users without having to update the application. Conversions of one system to a newer software version or to a completely different software product can be achieved with no adverse impact to the other system. This is especially important today, as computer technology changes rapidly, and the products available are constantly being improved.

The DBMS will operate on an IBM-compatible personal computer, with the following requirements: 3.1 Windows or higher (including Windows 95), 8 MB RAM (16 preferred), and a 486 processor (Pentium preferred).

The DBMS was designed for use by ACAA members, a broad user base consisting of CCB management and use personnel within electric utilities, representatives from marketing companies, coal companies, universities, and consultants. Version 1.0 of the program contains general features that will be useful to all members. These features were first outlined by the ACAA technical committee and subsequently by a task group formed under the technical committee.

The Database Engine

The database was designed using traditional database management design strategies. Individual pieces of data are stored in fields (columns), which belong to tables. Tables are related to one another through the use of primary and foreign keys. Indexes placed on fields are used in sorting and queries. Other rules and constraints are identified and applied to fields and tables.

Identifying Data Types

Several meetings with the ACAA technical committee task force resulted in the identification of the kinds of information to be included in the database. The database will be "CCB sample-oriented"; that is, all of the information collected for the database will be associated with a coal combustion by-product sample. A draft form was developed to contain all of the data that will be collected for the database (see Appendix A). This provides the submitters of data with the information that they need to collect the data; however, the data do not have to be transferred to this form. Data will be accepted for input to the database in a variety of formats, including electronic files such as spreadsheets or paper documents such as laboratory reports. Four main categories of information are included in the database: samples, engineering design data, characterization data, and utilization potential.

Samples. Descriptive information about the sample that was analyzed, such as the material type (fly ash, bottom ash, bed material, pulverized coal etc.), the sample description, and the date sampled, will be collected. Information related to the generation of the sample will also be collected, including items such as the type of fuel, the collection device or method used, and the location of the sample in the unit. Other operating conditions may be provided as deemed relevant by the submitter of the data. The sample number provided by the submitter will be accessible only to the submitter. A unique sample identification number will be assigned by the database to each new sample as it is entered.

Engineering Design Data. Design features of the engineering system influence the type and quality of the CCBs produced. For example, ash properties can be affected by fuel and boiler type. A furnace that is designed to burn eastern bituminous coals, but has switched to burning western subbituminous coals, will exhibit different ash properties than a furnace designed for and burning western subbituminous coals, even though both furnaces burn the same fuel. The type of collection device, for example, electrostatic precipitator (ESP) versus fabric filter, may have effects on the ash collected. NO_x control technologies can affect the amount of unburned carbon that can be directly related to loss on ignition (LOI). Ashes with elevated LOIs are not as readily marketed for cement and concrete as ashes with low LOI.

Data that are relevant to the configuration of the system producing the CCB will be collected. This information includes design fuel specification, steam generator type and manufacturer, furnace type and manufacturer, SO_2 and NO_x control information, and ash management configurations. The location of the plant will be identified by region only.

Characterization Data. Characterization data include chemical, mineralogical, and physical characterization data for the CCB and/or the fuel. Over 70 parameters have been identified for inclusion in the database. So that characterization data can be used in a comparative manner in reports and graphs, standard units have been assigned to the identified parameters. Other parameters will be added as submitted by members.

Utilization Potential. One or more potential utilization options can be identified for each CCB sample. These options are distinguished at the discretion of the submitter of data, and are not necessarily related to analytical or engineering information associated with the sample.

Keeping Data Confidential

The ACAA recognizes the need to maintain confidentiality of the source of the data. Confidentiality is maintained during sample collection and by the design of the database engine. All of the data are submitted directly to the EERC from the member. Information that is shaded on the collection form, such as the plant name, address, and unit name, **are not entered in the database at all**. The sample number provided by the submitter is input to a security table, which remains at the EERC. When disks are created for members, only the sample numbers provided by the member are copied into their database. In this way, members have access to their own sample numbers for query and viewing samples, but are not compromising the confidentiality of their data.

Data Model

Once the data types had been identified, the conceptual data model was designed. This is shown in Figure 1. It is from this conceptual model that the actual tables, indexes, constraints, and rules are developed in the database engine. It is important to have a good design strategy, so that the database can be expanded without difficulty. For example, it would be quite easy to add a production statistics table and relate it to the engineering table in the future.

The Database Application

The database application is the user interface to the database. The variety of features that could be designed for a DBMS are endless; thus, a specific set of features must be developed for the database application. Again, the ACAA technical committee task group was instrumental in deciding the important features for the first version of the database, listed below:

- The ability to perform multiple-criteria queries of the database to produce a set of samples for further study

- The creation of standard reports, such as C618 reports

- The ability to compare and contrast selected analytical results for selected samples in both graphs and tables

- The ability to graph utilization information for selected samples or regions

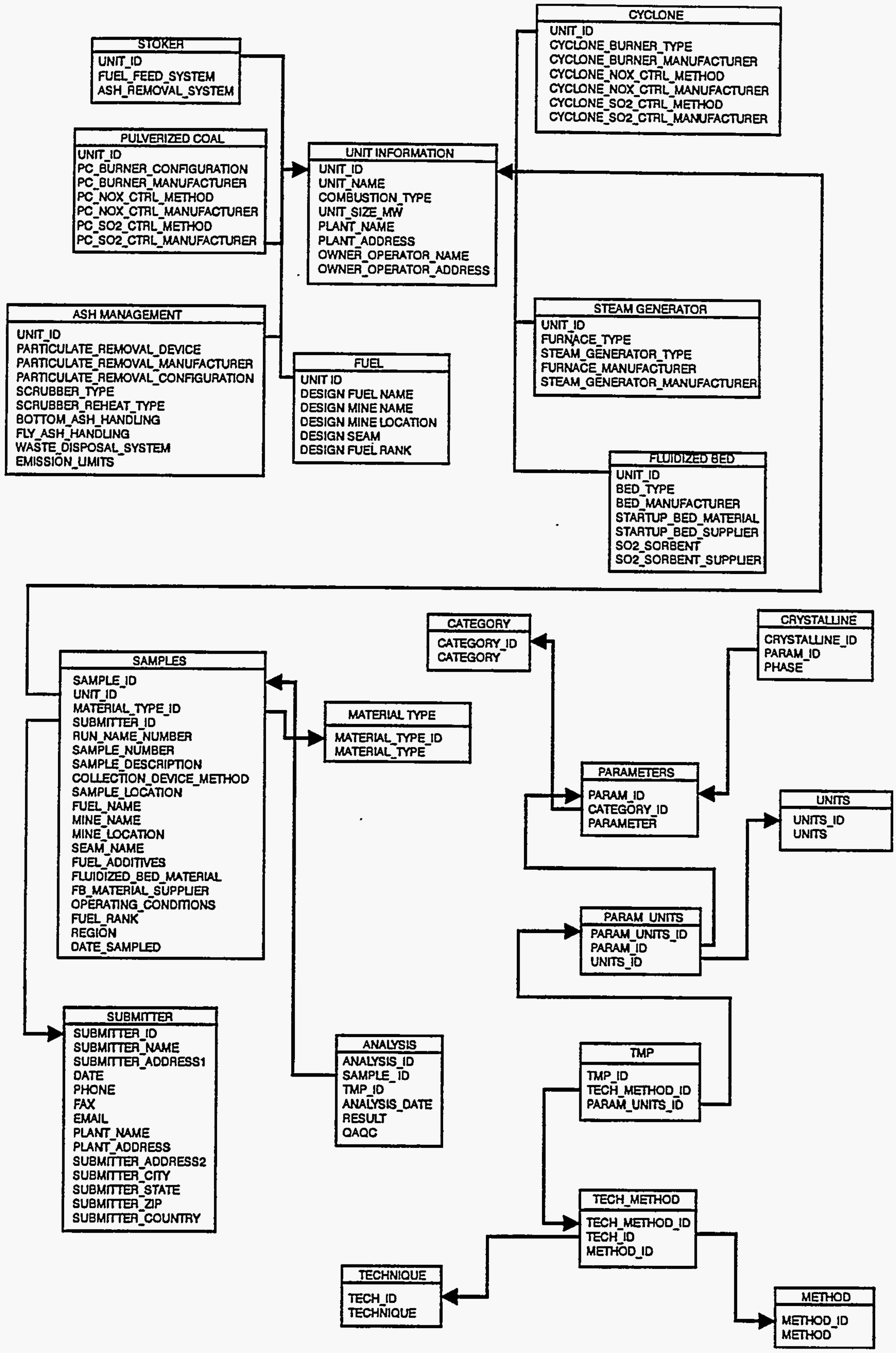

Figure 1
Conceptual Data Model

Figure 2 displays the major components of the design of the application and the terminology that will be used in the discussion of the database features. When the application is initiated, a window with the main menu is presented. The MicroHelp bar at the bottom of the window displays the current number of samples in the database (which will equal the total number of samples contained in the database unless a query has been performed). As menu items are chosen, sheet(s) are opened displaying information relative to the chosen menu item, and the menu items may change to correspond to the sheet. The major main menu features of the application are Query, Select, Report and Graph. Each feature is discussed in detail below.

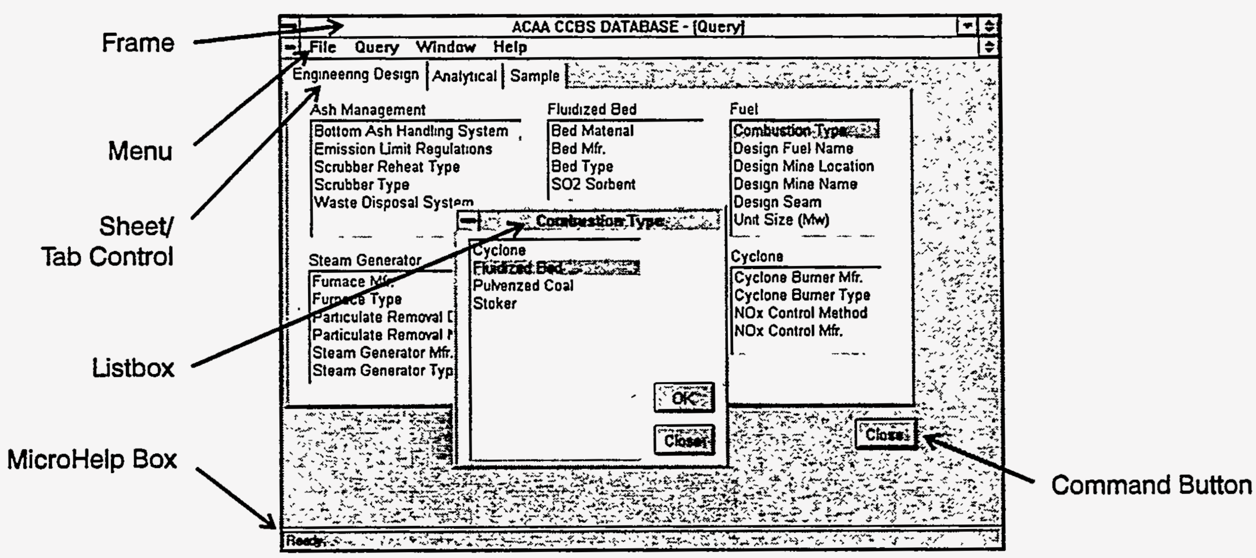

Figure 2
Major Design Components

Query

When the program is initiated, all of the samples are available for use in reports and graphs. Users are more often interested in a specific set of samples, for example, samples from a specific region or samples matching specific analytical results. Query provides a way to reduce the entire sample set to a set of samples matching specific criteria. Almost all of the data fields shown on the collection form can be used as search criteria. An example of the Query sheet is shown in Figure 3. The data fields have been placed into major categories on tab controls (Analytical, Engineering, and Utilization). Users can move from tab control to tab control, applying any combination of search criteria.

Each time that a set of criteria is applied, a new total of samples matching the search criteria is displayed at the bottom of the main window. In the SQL statement that is sent to the database

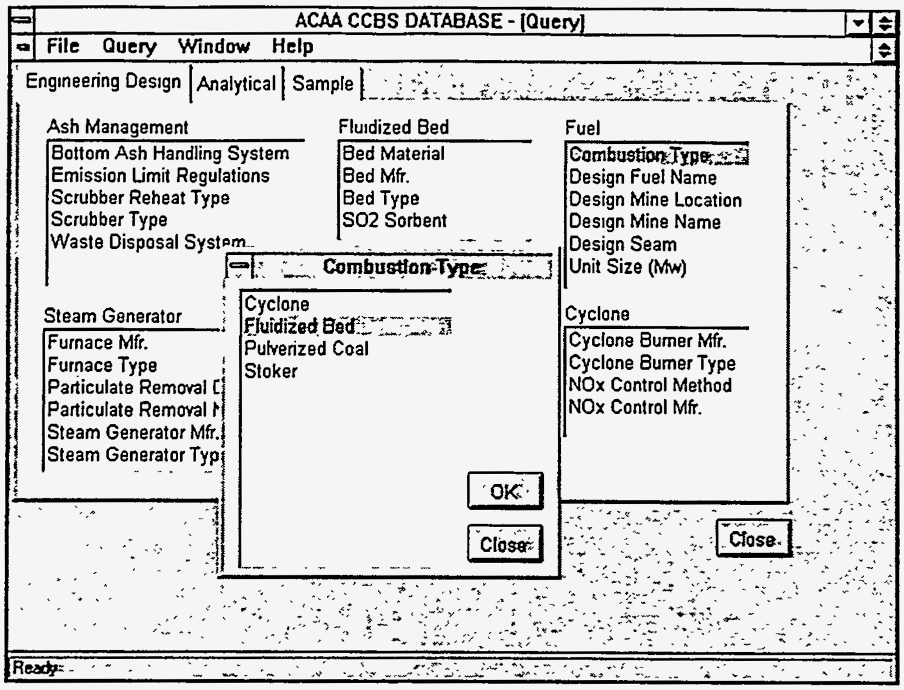

Figure 3
The Query Feature

for data retrieval, selections from within listboxes are considered to be joined by "or," and selections from individual data fields are considered to be joined by "and." Queries can range from very simple to quite complex. When working with queries, it is helpful to apply your most general criteria first. Examples of the steps involved in a query and the number of samples returned follow:

- Retrieve all samples where the material type is "fly ash" or "bottom ash." (Samples retrieved = 400.)
- Retrieve all samples where the material type is "fly ash" or "bottom ash," and the utilization potential is "cement and concrete products." (Samples retrieved = 350.)
- Retrieve all samples where the material type is "fly ash" or "bottom ash," and the utilization potential is "cement and concrete products" that came from "Region 1." (Samples retrieved = 200.)
- Retrieve all samples where the material type is "fly ash" or "bottom ash," and the utilization potential is "cement and concrete products" that came from "Region 1" and the samples "passed C618." (Samples retrieved = 120.)

It is possible to apply a query in which no samples meet the criteria. In this case, a message informs you that you have no matching samples, and you are returned to the query sheet to begin a fresh query. Selecting the same data from a listbox from the same data field twice in one query will *always* reduce your sample set to zero. This is because the SQL statement would look like this: Retrieve all the samples where the material type is "fly ash" *and* the material type is "coal."

Between each query, the Select feature can be used to view the samples that match the query. Once a query has been completed, reports and graphs are based on the samples resulting from the query. However, the set of samples can be further reduced by using the Select feature.

Select

Select provides you with four different ways of looking at the samples returned from your query, so that you may choose exactly which samples for which to report or graph. The first sheet gives descriptive information about the sample, such as the sample description, material type, formation date, and region. The second sheet provides you with engineering information related to each sample, such as boiler manufacturer and combustion type. The third sheet displays the various characterization testing that has been performed on the samples. The fourth sheet provides you with the potential applications that have been identified for each sample. Figure 4 gives an example of the select feature. As you click on an individual sheet, it will move to the front of the screen, becoming the immediate focus of attention.

Each sheet lists the unique sample numbers in the leftmost column. Initially, all of the samples are selected (highlighted). You can deselect (unhighlight) or reselect any sample by clicking on the row. As you select or deselect a sample from any one sheet, the corresponding sample is also selected/deselected in the other sheets.

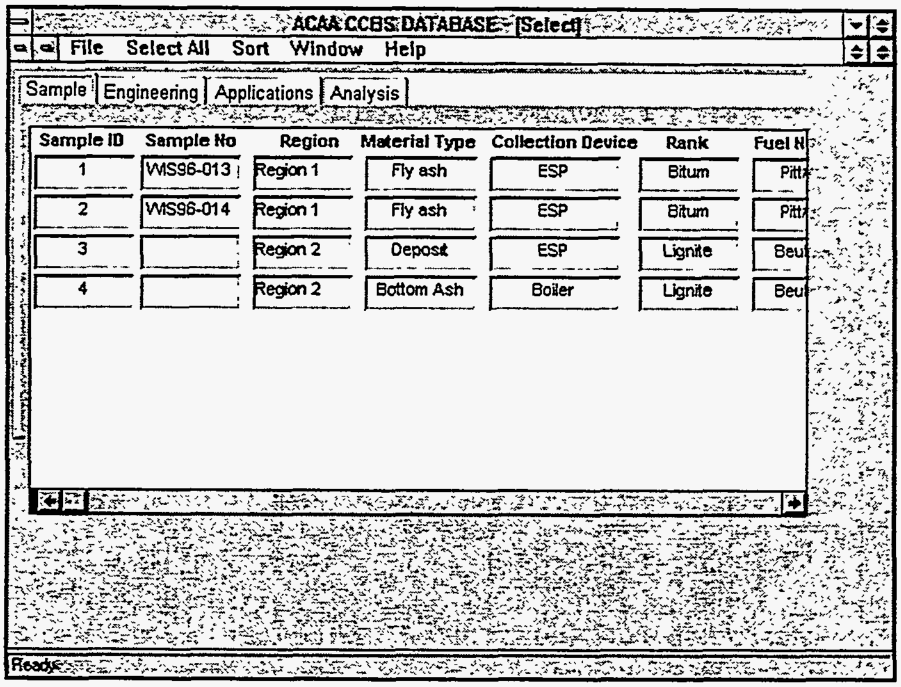

Figure 4
The Select Feature

If you have not performed a query on the database, and you choose the Select feature, all of the samples in the database would be listed on the four sheets. As this would take considerable resources (and possibly time), you are prompted as to whether or not you wish to first perform a query.

Reports

Several standard reports are built into the database; these are selected from a drop-down menu displayed when the Reports menu item is chosen. You can have one or more report sheets open at the same time, as shown in Figure 5. The reports are based on 1) the entire sample set if no query has been performed, 2) the samples matching the query, or 3) the samples selected from the query using the Select feature. Samples can be sorted before being printed. Print options will include several options for exporting the sample for use in another software program. Following is a brief description of the report options:

- Laboratory report – For each sample, the laboratory results are provided, as well as any QA/QC information, analytical technique, laboratory name, and date analyzed.
- C618 report – Report of C618 results for each sample, in a format which includes the C618 standards.
- Leaching report – Report of leaching results for each sample, including leaching standards.

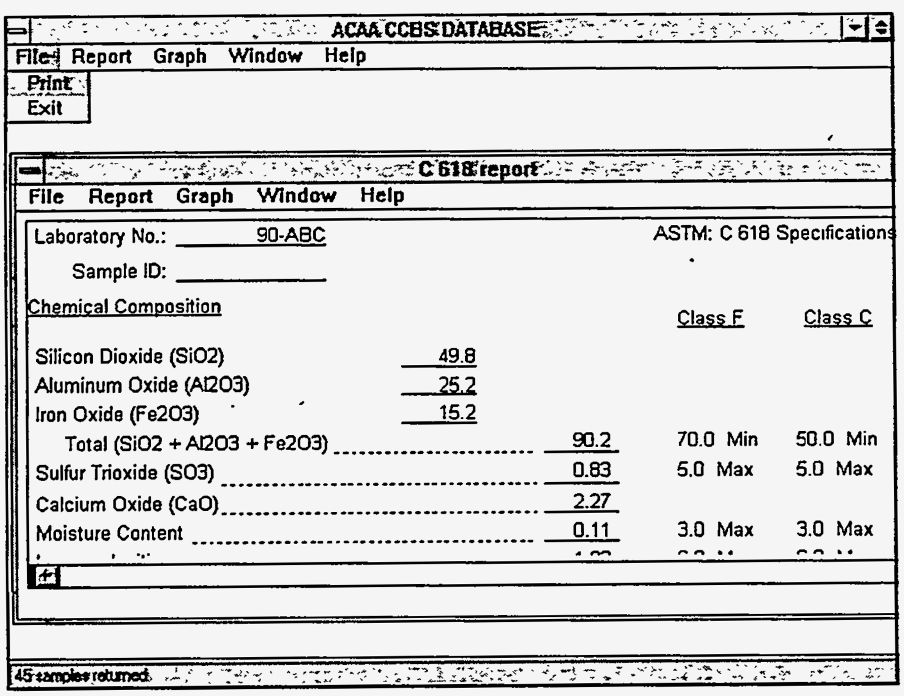

Figure 5
The Report Feature

- Sample report – Report listing each sample, with descriptive sample and engineering information, including region, and a summary of the types of characterization performed on each sample and the potential applications identified for each sample.

Graph

The Graph feature is similar to Reports in that a drop-down menu displays standard graphs, which have been designed in the application. Also, like reports, graphs are based on either the entire sample set or on the samples selected through Query or Select. However, most graphs need to have additional criteria applied to them before the graph is created. For example, if the graph "Regions vs: Applications" is chosen, the user will also have to choose the specific parameters to graph. (The samples have already been chosen via Query or Select.) In addition, each graph sheet has a variety of options for working with the graph. The type of graph may be changed, as well as the labels for the series, category, and heading. The data can also be presented as a table instead of a graph. More than one graph sheet can be displayed at one time. Reports and graph sheets can also be displayed simultaneously. Figure 6 shows a graph of Regions vs: Applications.

The available graphs include the following:

- Regions vs: Applications – This graph displays statistics for the total number of selected applications identified for each sample, grouped by selected region, as either a total count or a percent of the total.

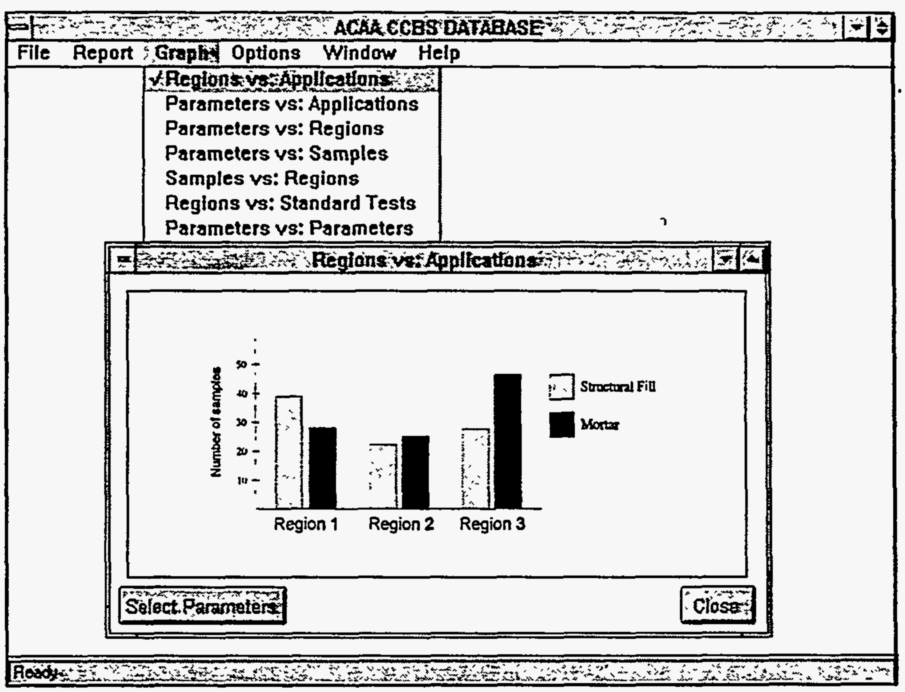

Figure 6
The Graph Feature

- Parameters vs: Applications – This graph displays statistical results for selected analytical parameters, grouped for selected applications. Users can select from Average, Minimum, Maximum, or Count as the value displayed for the analytical result.

- Parameters vs: Regions – This graph displays statistical results for selected analytical parameters, grouped for selected regions. Users can select from Average, Minimum, Maximum, or Count as the value displayed for the analytical result.

- Parameters vs: Samples – This graph displays results from selected analytical parameters for selected samples.

- Samples vs: Regions – This graph displays statistics for the total number of selected samples, grouped by selected region, as either a total count or a percent of the total.

- Regions vs: Standard Tests – This graph displays the percent or count of all samples for all regions that pass a standard test (C618 or leaching) and the percent or count of all samples within a region that pass a standard test (C618 or leaching).

- Parameters vs: Parameters – This graph displays analytical results of a set of selected parameters against a different set of selected parameters (x–y graph).

Applications

While the utility of this database cannot be fully realized until it is available to the users, the potential applications are numerous. ACAA members who are CCB producers would be able to compare CCBs produced at their plant(s) with CCBs produced under similar conditions. CCB producers and marketers could compare CCB properties and elucidate new ways to utilize a particular CCB. Depending upon the local competing materials and transportation costs, new markets may become apparent. Members could use the database to plan for changes in fuel sources or other physical changes in the plant that will affect the quality of their ash by comparing anticipated changes to similar systems. Marketers will be able to examine product consistency over a period of time. Marketers may also be able to identify certain coal/boiler/collection/storage condition interactions that may produce CCBs with specific properties. Researchers could use the database to identify amounts of CCBs that may be specified for emerging technologies and to make predictions of trends in CCB utilization. The database will allow all users to determine how particular CCBs relate to the rest of the CCBs in the database.

The database has a wide variety of uses, which ultimately depend on the data that are provided by the members. The more data contained in the database, the more relevant the comparison of characterization and utilization information.

APPENDIX A
COLLECTION FORM FOR DATABASE

Sample Information

Complete for each sample analyzed.

Sample Number:	Unit Name:	Run Name/Number	Date Sampled:

Sample Description:

Material Type

- Coal
- Pet-Coke
- RDF
- Fly Ash — C / F
- Bottom Ash
- Deposit
- Slag
- Hopper Ash
- Bed Material
- Sorbent
- Other (describe):

Collection Device / Method:	Location of Sample in Unit:
Fuel Name	Rank:
Mine Name	Mine Location:
Seam	Fuel Additives:

FLUIDIZED-BED SYSTEMS

Bed Material and Supplier	SO_2 Sorbent and Supplier

Other Significant Operating Conditions Affecting Sample Formation or Results:

Potential Applications (check all that apply):

Cement and Concrete Products	Grouting	Filler in Metals
Flowable Fill	Mining Applications	Synthetic Aggregate
Structural Fill/Embankments	Wallboard	Agricultural Soil Amendment
Roadbase/Subbase	Waste Stabilization/Solidification	pH Control
Mineral Filler in Asphalt	Mineral Wool	Backfill
Snow and Ice Control	Filler in Plastics	Filler in Coatings
Blasting Grit/Roofing Granules	Filler in Paint	Other (be specific): ______

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Submitter Information

Submitter Name:	Date:
Company Name:	Phone:
Address:	Fax: E-Mail:

Engineering Design

Complete for each unit.

Power Company:	Plant Name:	Plant Address (city, state):
Unit Name:	Combustion Type: Pulverized Coal / Cyclone Fluidized Bed / Stoker	Unit Size (MWe)

Region (see attached map):

- Region 1
- Region 2
- Other ______
- Region 3
- Region 4
- Region 5
- Region 6

Fuel

Design Fuel Name:	Design Rank:
Design Mine Name:	Design Mine Location:
Design Seam:	

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Engineering Design (cont.)

Steam Generator

Furnace Type (pressurized, balanced draft, etc.):	Furnace Manufacturer
Steam Generator Type (drum, once-through, etc.):	Steam Generator Manufacturer:

PC	Cyclone	Fluidized Bed	Stoker
Burner Configuration (one wall, opposed wall, tangential, etc.):	Cyclone Burner Type:	Bed Type (bubbling, circulating, etc):	Fuel Feed System (spreader, etc.):
Burner Manufacturer:	Cyclone Burner Manufacturer	Bed Manufacturer	
NO_x Control? Method: Manufacturer:	NO_x Control? Method: Manufacturer:	Start-up Bed Material & Supplier	Ash Removal System (traveling grate, etc.):
SO_x Control? Method: Manufacturer:	SO_x Control? Method: Manufacturer	SO2 Sorbent & Supplier	

Ash Management

Particulate Removal Device (ESP, fabric filters, etc.):	Particulate Removal Manufacturer	
Particulate Removal Configuration (#, efficiency):	Scrubber Type (wet, dry):	Type of Scrubber Reheat (cool gas, hot gas, etc.):

Type of Ash Handling System: Bottom Ash: Fly Ash:	Waste Disposal System (dry-landfill, wet-pond): Emission Limits - under what emission limits is the unit regulated?

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Sample Number:

Chemical Analysis

Parameter	Technique	Method	Date Analyzed	Result	Units	QA/QC Notes
RCRA ELEMENTS						
As					µg/g	
Ag					µg/g	
Ba					µg/g	
Cd					µg/g	
Cr					µg/g	
Hg					ug/g	
Pb					ug/g	
Se					ug/g	
LEACHATE						
As					mg/L	
Ag					mg/L	
Ba					mg/L	
Cd					mg/L	
Cr					mg/L	
Hg					mg/L	
Pb					mg/L	
Se					mg/L	

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Chemical Analysis

Sample Number

Parameter	Technique	Method	Date Analyzed	Result	Units	QA/QC Notes
SiO_2					wt%	
Al_2O_3					wt%	
Fe_2O_3					wt%	
Sum of SiO_2, Al_2O_3, Fe_2O_3					wt%	
CaO					wt%	
SO_3					wt%	
Na_2O					wt%	
K_2O					wt%	
P_2O_5					wt%	
TiO_2					wt%	
BaO					wt%	
MnO_2					wt%	
SrO					wt%	
MgO					wt%	
pH						
Moisture Content					wt%	
Loss on Ignition					wt%	
Available Alkalies					wt% as Na_2O	
Pozzolanic Activity/Cement					%	
Pozzolanic Activity/Lime					psi	
Water Requirement					%	

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Sample Number:

Physical Analysis

Parameter	Technique	Method	Date Analyzed	Result	Units	QA/QC Notes
Unit Weight					lb/ft³	
Max-Dry Density					lb/ft³	
Optimum Moisture Content					wt%	
Unconfined Compressive Strength					psi	
Angle of Internal Friction (ϕ)					degrees (°)	
Coefficient of Permeability (k)					cm/s	
D[illegible]					mm	
D[illegible]					mm	
Bearing Capacity					psf	
Specific Gravity						
Wet Density					lb/ft³	
Dry Density					lb/ft³	
Cohesion					psf	
Particle-Size Distribution					% - mm	
Flow Test					%	
Slump Test					in	
Penetration Test					psi	
Bulk Density					lbs/ft³	
Surface Area					cm²/g	
Fineness					%	
Increase in Drying Shrinkage					%	
Autoclave Expansion					%	
SG Variability					%	
Fineness Variability					%	
AEA Demand					oz/yd³	
Mortar Expansion					%	

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Sample Number:

Mineralogical Analysis

Parameter	Technique	Method	Date Analyzed	Result	Units	QA/QC Notes
% Crystalline					wt%	
% Amorphous					wt%	
CRYSTALLINE PHASES PRESENT						
Calcium Sulfates						
					wt%	
					wt%	
					wt%	
Iron Oxides						
					wt%	
					wt%	
Calcium Aluminates						
					wt%	
					wt%	
					wt%	
Spinels						
					wt%	
					wt%	
Sodalites						
					wt%	
Calcium Oxides/Hydroxides						
					wt%	
Melilites						
					wt%	
Quartz					wt%	
Mullite					wt%	
Merwinite					wt%	
Periclase					wt%	

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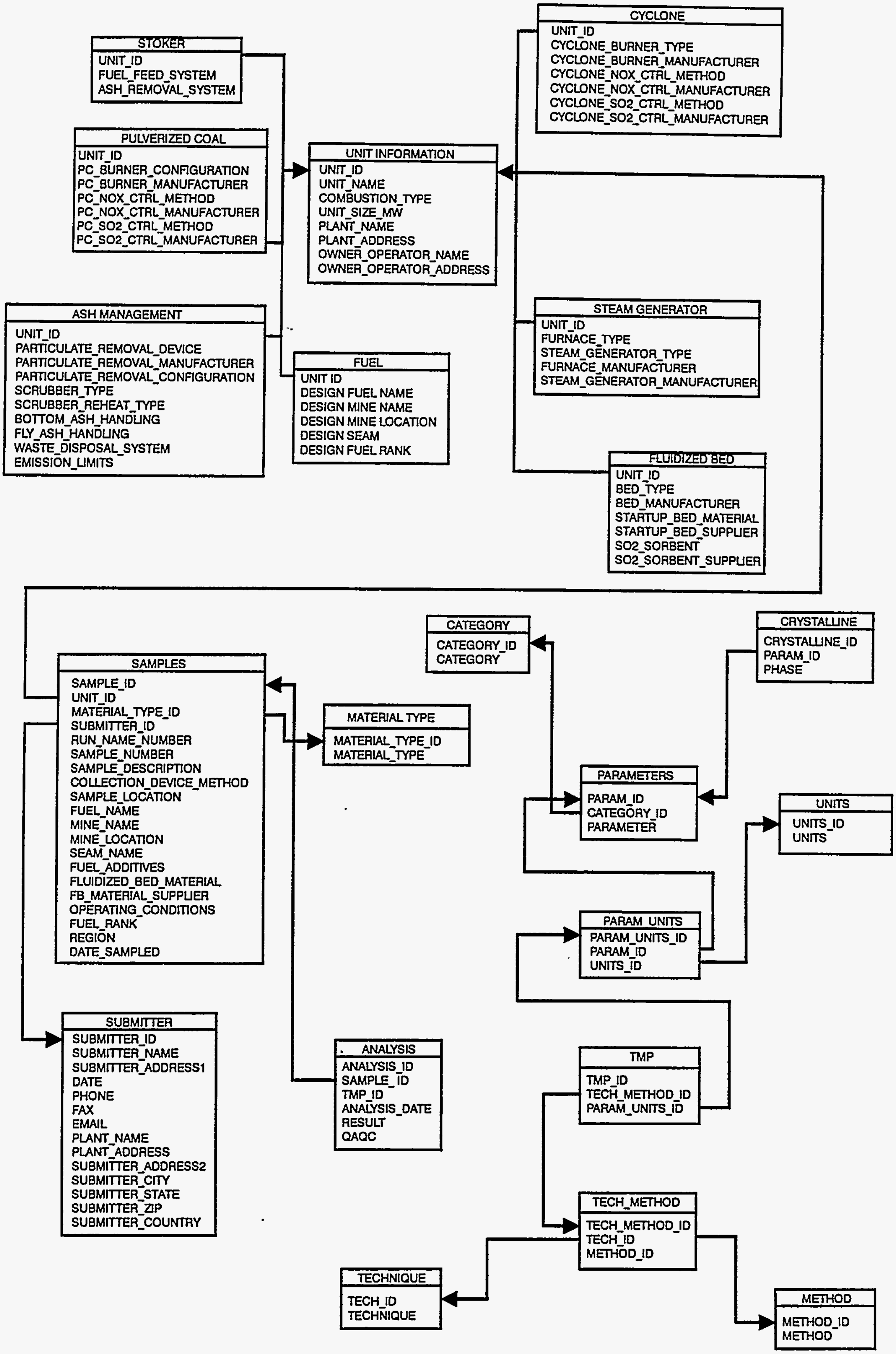
STOKER
UNIT_ID
FUEL_FEED_SYSTEM
ASH_REMOVAL_SYSTEM
CYCLONE
UNIT_ID
CYCLONE_BURNER_TYPE
CYCLONE_BURNER_MANUFACTURER
CYCLONE_NOX_CTRL_METHOD
CYCLONE_NOX_CTRL_MANUFACTURER
CYCLONE_SO2_CTRL_METHOD
CYCLONE_SO2_CTRL_MANUFACTURER
PULVERIZED COAL
UNIT_ID
PC_BURNER_CONFIGURATION
PC_BURNER_MANUFACTURER
PC_NOX_CTRL_METHOD
PC_NOX_CTRL_MANUFACTURER
PC_SO2_CTRL_METHOD
PC_SO2_CTRL_MANUFACTURER
UNIT INFORMATION
UNIT_ID
UNIT_NAME
COMBUSTION_TYPE
UNIT_SIZE_MW
PLANT_NAME
PLANT_ADDRESS
OWNER_OPERATOR_NAME
OWNER_OPERATOR_ADDRESS
ASH MANAGEMENT
UNIT_ID
PARTICULATE_REMOVAL_DEVICE
PARTICULATE_REMOVAL_MANUFACTURER
PARTICULATE_REMOVAL_CONFIGURATION
SCRUBBER_TYPE
SCRUBBER_REHEAT_TYPE
BOTTOM_ASH_HANDLING
FLY_ASH_HANDLING
WASTE_DISPOSAL_SYSTEM
EMISSION_LIMITS
STEAM GENERATOR
UNIT_ID
FURNACE_TYPE
STEAM_GENERATOR_TYPE
FURNACE_MANUFACTURER
STEAM_GENERATOR_MANUFACTURER
FUEL
UNIT ID
DESIGN FUEL NAME
DESIGN MINE NAME
DESIGN MINE LOCATION
DESIGN SEAM
DESIGN FUEL RANK
FLUIDIZED BED
UNIT_ID
BED_TYPE
BED_MANUFACTURER
STARTUP_BED_MATERIAL
STARTUP_BED_SUPPLIER
SO2_SORBENT
SO2_SORBENT_SUPPLIER
CATEGORY
CATEGORY_ID
CATEGORY
CRYSTALLINE
CRYSTALLINE_ID
PARAM_ID
PHASE
SAMPLES
SAMPLE_ID
UNIT_ID
MATERIAL_TYPE_ID
SUBMITTER_ID
RUN_NAME_NUMBER
SAMPLE_NUMBER
SAMPLE_DESCRIPTION
COLLECTION_DEVICE_METHOD
SAMPLE_LOCATION
FUEL_NAME
MINE_NAME
MINE_LOCATION
SEAM_NAME
FUEL_ADDITIVES
FLUIDIZED_BED_MATERIAL
FB_MATERIAL_SUPPLIER
OPERATING_CONDITIONS
FUEL_RANK
REGION
DATE_SAMPLED
MATERIAL TYPE
MATERIAL_TYPE_ID
MATERIAL_TYPE
PARAMETERS
PARAM_ID
CATEGORY_ID
PARAMETER
UNITS
UNITS_ID
UNITS
PARAM_UNITS
PARAM_UNITS_ID
PARAM_ID
UNITS_ID
SUBMITTER
SUBMITTER_ID
SUBMITTER_NAME
SUBMITTER_ADDRESS1
DATE
PHONE
FAX
EMAIL
PLANT_NAME
PLANT_ADDRESS
SUBMITTER_ADDRESS2
SUBMITTER_CITY
SUBMITTER_STATE
SUBMITTER_ZIP
SUBMITTER_COUNTRY
ANALYSIS
ANALYSIS_ID
SAMPLE_ID
TMP_ID
ANALYSIS_DATE
RESULT
QAQC
TMP
TMP_ID
TECH_METHOD_ID
PARAM_UNITS_ID
TECH_METHOD
TECH_METHOD_ID
TECH_ID
METHOD_ID
TECHNIQUE
TECH_ID
TECHNIQUE
METHOD
METHOD_ID
METHOD

Sample Information

Complete for each sample analyzed.

Sample Number:	Unit Name:	Run Name/Number:	Date Sampled:
Sample Description:			

Material Type:

- ☐ Coal
- ☐ Pet-Coke
- ☐ RDF
- ☐ Fly Ash ☐ C ☐ F
- ☐ Bottom Ash
- ☐ Deposit
- ☐ Slag
- ☐ Hopper Ash
- ☐ Bed Material
- ☐ Sorbent
- ☐ Other (describe): ____________

Collection Device / Method:	Location of Sample in Unit:

Fuel Name:	Rank:
Mine Name:	Mine Location:
Seam:	Fuel Additives:

FLUIDIZED-BED SYSTEMS

Bed Material and Supplier: SO_2 Sorbent and Supplier:

Other Significant Operating Conditions Affecting Sample Formation or Results:

Potential Applications (check all that apply):

- ☐ Cement and Concrete Products
- ☐ Flowable Fill
- ☐ Structural Fill/Embankments
- ☐ Roadbase/Subbase
- ☐ Mineral Filler in Asphalt
- ☐ Snow and Ice Control
- ☐ Blasting Grit/Roofing Granules
- ☐ Grouting
- ☐ Mining Applications
- ☐ Wallboard
- ☐ Waste Stabilization/Solidification
- ☐ Mineral Wool
- ☐ Filler in Plastics
- ☐ Filler in Paint
- ☐ Filler in Metals
- ☐ Synthetic Aggregate
- ☐ Agricultural Soil Amendment
- ☐ pH Control
- ☐ Backfill
- ☐ Filler in Coatings
- ☐ Other (be specific): ____________

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Submitter Information

Submitter Name:	Date:
Company Name:	Phone:
Address:	Fax: E-Mail:

Engineering Design

Complete for each unit.

Power Company:	Plant Name:	Plant Address (city, state):
Unit Name:	Combustion Type: ☐ Pulverized Coal ☐ Cyclone ☐ Fluidized Bed ☐ Stoker	Unit Size (MWe):

Region (see attached map):

- ☐ Region 1
- ☐ Region 2
- ☐ Other____________
- ☐ Region 3
- ☐ Region 4
- ☐ Region 5
- ☐ Region 6

Fuel

Design Fuel Name:	Design Rank:
Design Mine Name:	Design Mine Location:
Design Seam:	

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Engineering Design (cont.)

Steam Generator

Furnace Type (pressurized, balanced draft, etc.):	Furnace Manufacturer:
Steam Generator Type (drum, once-through, etc.):	Steam Generator Manufacturer:

PC	Cyclone	Fluidized Bed	Stoker
Burner Configuration (one wall, opposed wall, tangential, etc.):	Cyclone Burner Type:	Bed Type (bubbling, circulating, etc):	Fuel Feed System (spreader, etc.):
Burner Manufacturer:	Cyclone Burner Manufacturer:	Bed Manufacturer:	
NO_x Control? Method: Manufacturer:	NO_x Control? Method: Manufacturer:	Start-up Bed Material & Supplier:	Ash Removal System (traveling grate, etc.):
SO_2 Control? Method: Manufacturer:	SO_2 Control? Method: Manufacturer:	SO2 Sorbent & Supplier:	

Ash Management

Particulate Removal Device (ESP, fabric filters, etc.):	Particulate Removal Manufacturer:	
Particulate Removal Configuration (#, efficiency):	Scrubber Type (wet, dry):	Type of Scrubber Reheat (cool gas, hot gas, etc.):
Type of Ash Handling System: Bottom Ash: Fly Ash:	Waste Disposal System (dry-landfill, wet-pond): Emission Limits - under what emission limits is the unit regulated?	

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Sample Number:

Chemical Analysis

Parameter	Technique	Method	Date Analyzed	Result	Units	QA/QC Notes
RCRA ELEMENTS						
As					μg/g	
Ag					μg/g	
Ba					μg/g	
Cd					μg/g	
Cr					μg/g	
Hg					ug/g	
Pb					ug/g	
Se					ug/g	
LEACHATE						
As					mg/L	
Ag					mg/L	
Ba					mg/L	
Cd					mg/L	
Cr					mg/L	
Hg					mg/L	
Pb					mg/L	
Se					mg/L	

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Sample Number:

Chemical Analysis

Parameter	Technique	Method	Date Analyzed	Result	Units	QA/QC Notes
SiO_2					wt%	
Al_2O_3					wt%	
Fe_2O_3					wt%	
Sum of SiO_2, Al_2O_3, Fe_2O_3					wt%	
CaO					wt%	
SO_3					wt%	
Na_2O					wt%	
K_2O					wt%	
P_2O_5					wt%	
TiO_2					wt%	
BaO					wt%	
MnO_2					wt%	
SrO					wt%	
MgO					wt%	
pH						
Moisture Content					wt%	
Loss on Ignition					wt%	
Available Alkalies					wt% as Na_2O	
Pozzolanic Activity/Cement					%	
Pozzolanic Activity/Lime					psi	
Water Requirement					%	

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Sample Number:

Physical Analysis

Parameter	Technique	Method	Date Analyzed	Result	Units	QA/QC Notes
Unit Weight					lb/ft^3	
Max-Dry Density					lb/ft^3	
Optimum Moisture Content					wt%	
Unconfined Compressive Strength					psi	
Angle of Internal Friction (ϕ)					degrees (°)	
Coefficient of Permeability (k)					cm/s	
D[illegible]					mm	
D[illegible]					mm	
Bearing Capacity					psf	
Specific Gravity						
Wet Density					lb/ft^3	
Dry Density					lb/ft^3	
Cohesion					psf	
Particle-Size Distribution					% - mm	
Flow Test					%	
Slump Test					in	
Penetration Test					psi	
Bulk Density					lbs/ft^3	
Surface Area					cm^2/g	
Fineness					%	
Increase in Drying Shrinkage					%	
Autoclave Expansion					%	
SG Variability					%	
Fineness Variability					%	
AEA Demand					oz/yd^3	
Mortar Expansion					%	

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Sample Number:

Mineralogical Analysis

Parameter	Technique	Method	Date Analyzed	Result	Units	QA/QC Notes
% Crystalline					wt%	
% Amorphous					wt%	
CRYSTALLINE PHASES PRESENT						
Calcium Sulfates						
					wt%	
					wt%	
					wt%	
Iron Oxides						
					wt%	
					wt%	
Calcium Aluminates						
					wt%	
					wt%	
					wt%	
Spinels						
					wt%	
					wt%	
Sodalites						
					wt%	
Calcium Oxides/Hydroxides						
					wt%	
Melilites						
					wt%	
Quartz					wt%	
Mullite					wt%	
Merwinite					wt%	
Periclase					wt%	

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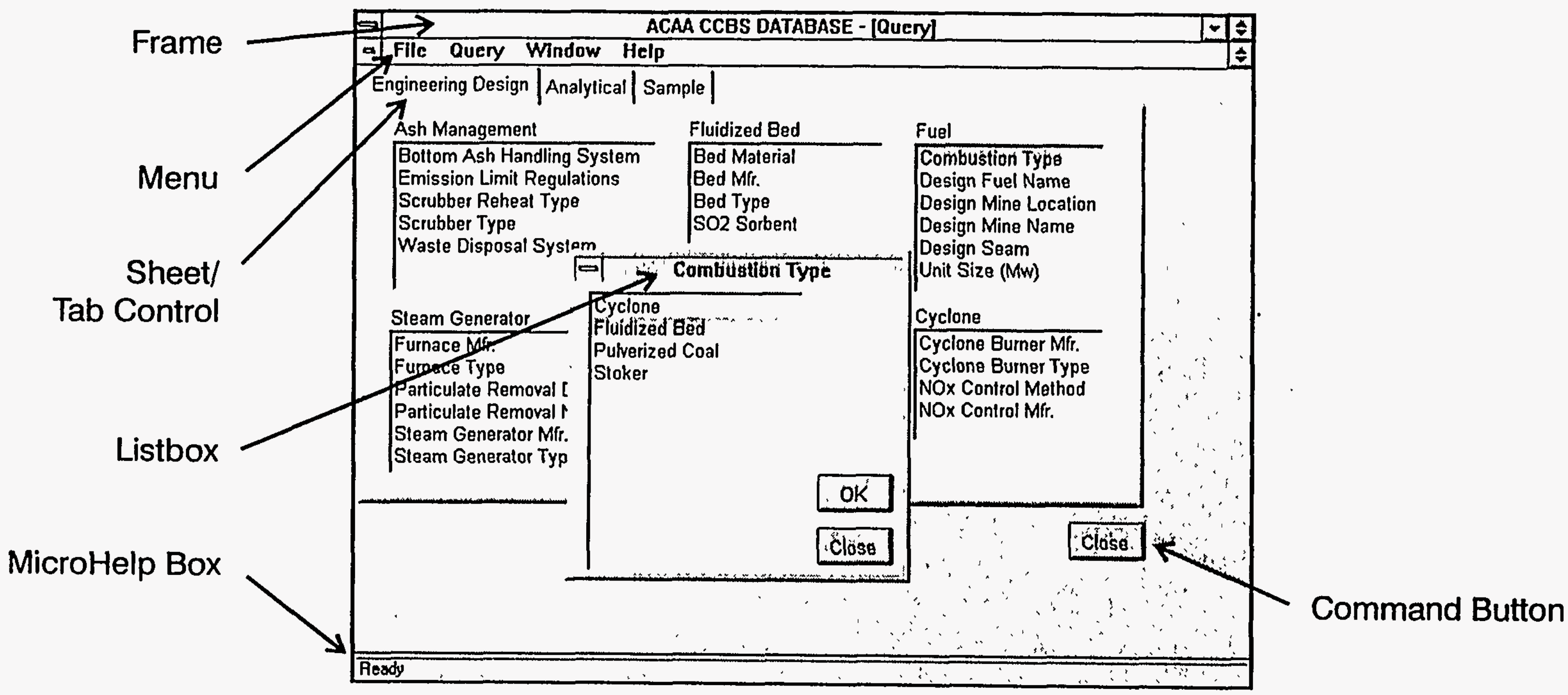
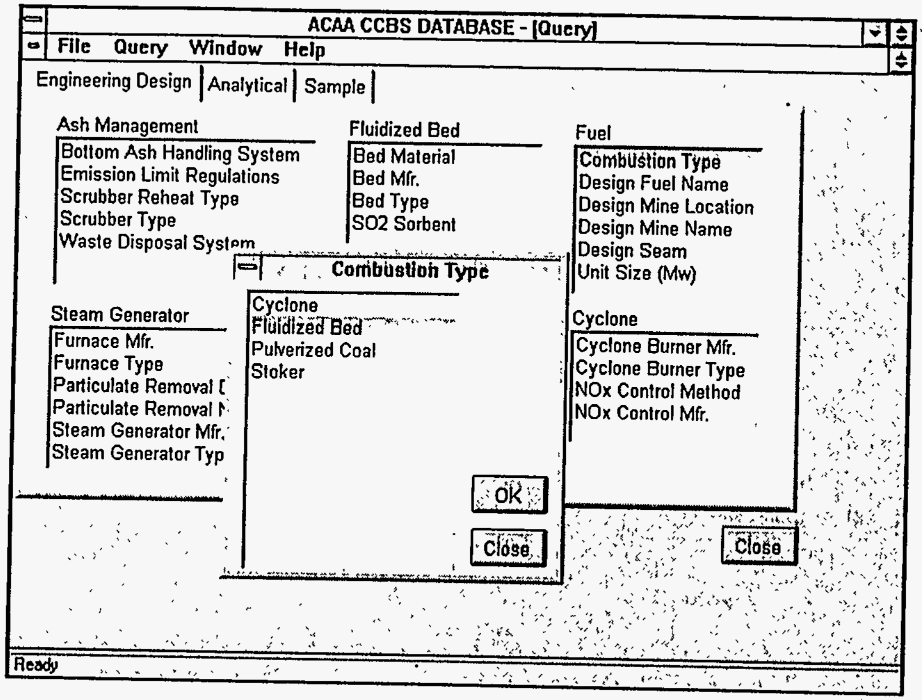

Frame
Menu
Sheet/
Tab Control
Listbox
MicroHelp Box
Command Button
ACAA CCBS DATABASE - [Query]
File
Query
Window
Help
Engineering Design
Analytical
Sample
Ash Management
Bottom Ash Handling System
Emission Limit Regulations
Scrubber Reheat Type
Scrubber Type
Waste Disposal System
Fluidized Bed
Bed Material
Bed Mfr.
Bed Type
SO2 Sorbent
Fuel
Combustion Type
Design Fuel Name
Design Mine Location
Design Mine Name
Design Seam
Unit Size (Mw)
Combustion Type
Cyclone
Fluidized Bed
Pulverized Coal
Stoker
OK
Close
Steam Generator
Furnace Mfr.
Furnace Type
Steam Generator Mfr.
Cyclone
Cyclone Burner Mfr.
Cyclone Burner Type
NOx Control Method
NOx Control Mfr.
Close
Ready


ACAA CCBS DATABASE - [Query]
File Query Window Help
Engineering Design
Analytical
Sample
Ash Management
Bottom Ash Handling System
Emission Limit Regulations
Scrubber Reheat Type
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Waste Disposal System
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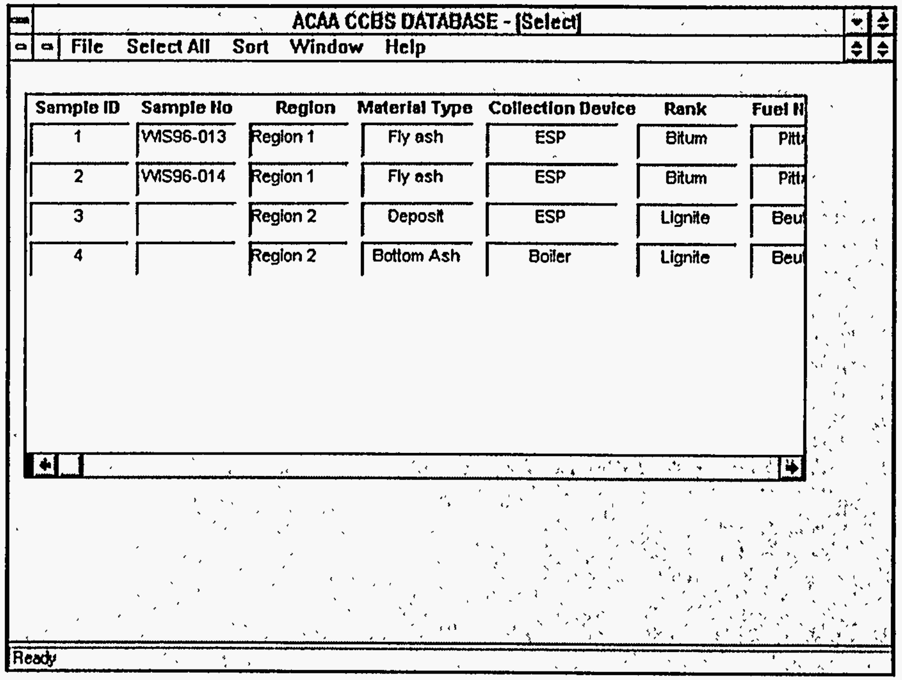
Bed Material
Bed Mfr.
Bed Type
SO2 Sorbent
Fuel
Combustion Type
Design Fuel Name
Design Mine Location
Design Mine Name
Design Seam
Unit Size (Mw)
Steam Generator
Furnace Mfr.
Furnace Type
Steam Generator Mfr.
Combustion Type
Cyclone
Fluidized Bed
Pulverized Coal
Stoker
OK
Close
Cyclone
Cyclone Burner Mfr.
Cyclone Burner Type
NOx Control Method
NOx Control Mfr.
Close
Ready

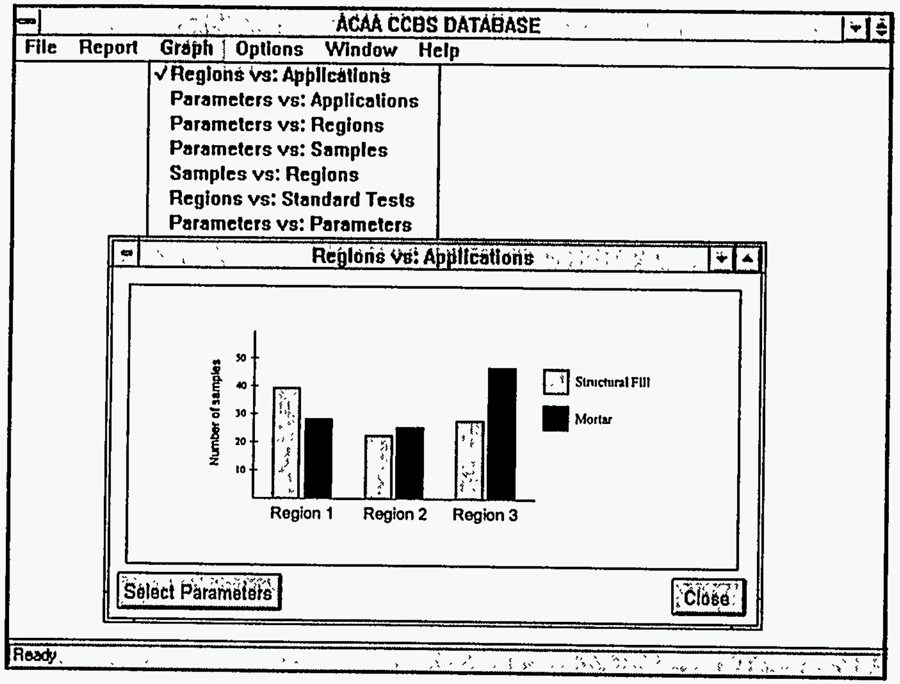


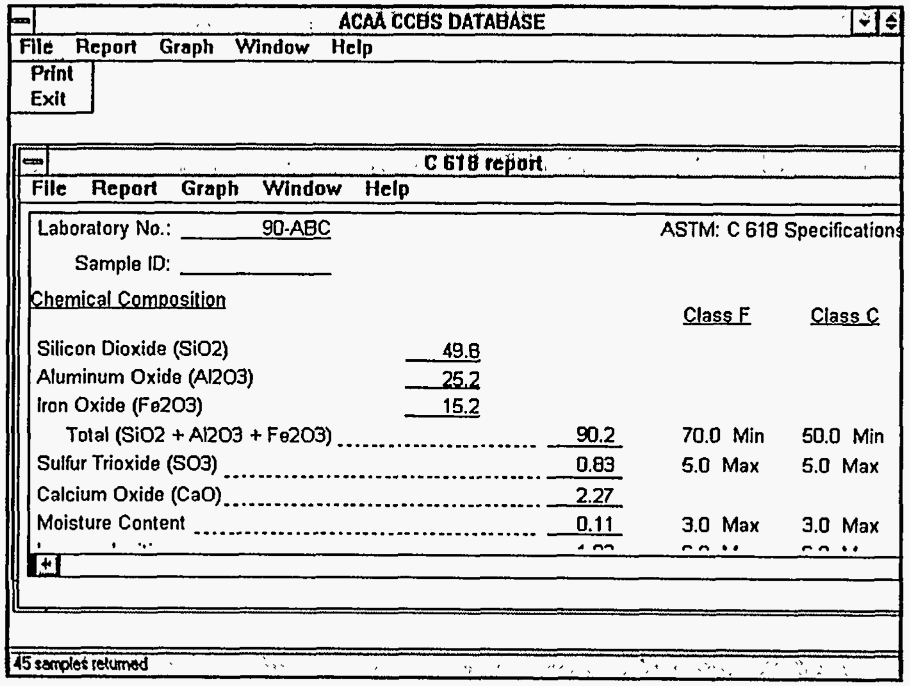
ACAA CCBS DATABASE - [Select]

File Select All Sort Window Help

Sample ID	Sample No	Region	Material Type	Collection Device	Rank	Fuel N
1	WIS96-013	Region 1	Fly ash	ESP	Bitum	Pitt
2	WIS96-014	Region 1	Fly ash	ESP	Bitum	Pitt
3		Region 2	Deposit	ESP	Lignite	Beu
4		Region 2	Bottom Ash	Boiler	Lignite	Beu

Ready


ACAA CCBS DATABASE
File
Report
Graph
Options
Window
Help
✓Regions vs: Applications
Parameters vs: Applications
Parameters vs: Regions
Parameters vs: Samples
Samples vs: Regions
Regions vs: Standard Tests
Parameters vs: Parameters
Regions vs: Applications
Number of samples
10
20
30
40
50
Region 1
Region 2
Region 3
Structural Fill
Mortar
Select Parameters
Close
Ready



Laboratory No.: 90-ABC

ASTM: C 618 Specifications

Sample ID:

Chemical Composition

			Class F	Class C
Silicon Dioxide (SiO_2)	49.8			
Aluminum Oxide (Al_2O_3)	25.2			
Iron Oxide (Fe_2O_3)	15.2			
Total (SiO_2 + Al_2O_3 + Fe_2O_3)		90.2	70.0 Min	50.0 Min
Sulfur Trioxide (SO_3)		0.83	5.0 Max	5.0 Max
Calcium Oxide (CaO)		2.27		
Moisture Content		0.11	3.0 Max	3.0 Max