The Virginia Electric and Power Company, like many eastern electric utilities, spends more on coal than any other fuel. The coal is purchased through long-term supply contracts and from the spot market. Each month up to several hundred vendors submit spot market bids for delivery the following month. Vepco must decide in about six working days what offers to accept and where each lot of coal should be shipped. To further complicate the situation, no two lots of coal are the same. Different physical properties of the coal can greatly affect its value to Vepco. Each power station has its own quality requirements and tolerance for impurities. Also, the coal vendor’s ability to perform must be considered.

The Spotplus system has simplified the coal procurement process. Spotplus is a TSO command list that calls SAS to permit editing or adding spot coal offers, freight rates, or long-term supply contracts. It also submits background jobs to produce various reports, migrates older data to mass storage, and can interface with a linear programming model that helps select and allocate coal offers.

Recording Market Data

A. General

Coal market data is divided into two types, contract and spot. The same data is kept for both types. The only difference is that the contracts have already been accepted and allocated to a power station. Because the contract data is almost the same from month to month, the same SAS dataset is used. Spot market offers are completely different every month so a different SAS dataset is used each month.

Spot coal offers are entered as they are received. A new SAS dataset is used for each month. The SAS name is determined by the month, such as "198301" for coal to be delivered in January 1983. Two system datasets are used to store coal market data. A disk dataset has spot market data for the three or four most current months contract data and graphic data. A mass storage dataset is used for older spot market data. The spotplus system can access current or old data for special studies.

B. User Data Entry

When the option to add or edit spot market data is selected, the user is prompted for the month and year these offers are for. The system then generates a temporary one-line dataset with a MACRO statement that causes the proper SAS dataset name such as "COAL_198301" to be associated with the MACRO name "DA-DATA.

SAS is called with a SYSIN option referring to the one-line dataset, a LOC option to cause the SAS log to be written to a dataset and the ERRORBEND option so the command list can determine if the data has been found. PROC FSEDIT is used to edit or add data. SAS will abend if the data can’t be found. If this happens, the system compares the month and year with the current date to determine if the month is new or if it has been migrated to the mass storage dataset. If it is new, then a new SAS dataset is created by copying the previous month’s data with the option OBS=0. If the data is old, then the mass storage dataset is allocated, and the temporary, one-line dataset is rewritten to refer to it.

C. System Data Editing

After the user is finished with FSEDIT, the system does additional editing automatically. For each offer the user has the option of entering the railroad name, freight district name, and freight rates to each power station or simply entering a rate schedule number. This number refers to the observation number of a dataset maintained by the Transportation Department with the railroad name, freight district name, and rates to each power station. The appropriate data is inserted unless the rate number is zero or missing. Observations are deleted if the vendor name is "Delete." If an offer is selected for shipment to a power station, then an abbreviation is changed to the station’s full name by checking the first or first three letters.

All of this is transparent to the user. The SAS log is written to a dataset and is not normally displayed. The log would fill about three screens and could confuse the user who is not familiar with SAS or electronic data processing. If SAS abends, the message "SASLP ended due to error" is generated by TSO. Spotplus adds the message "but don’t worry about it" then takes corrective action. If SAS abends a second time, then the dataset with the SAS log is listed on the screen. The ERRORBEND option ensures that the command list can detect any SAS problem.

D. Migrating Old Data to Mass Storage

We wish to retain old data for rate hearings and audits, however, a new SAS dataset every month would soon take up a lot of valuable disk space. A method was developed to automatically move data from the disk dataset to a mass storage dataset without bothering the user or requiring action on her.
part. Whenever the "Virginia Coal Report" is requested (usually once a month), the migrate job is also submitted automatically. PROC PRINTTO and PROC CONTENTS are used to generate a list on a temporary dataset of the SAS datasets on the disk file. This temporary dataset is read in a DATA step and a subset "T" is used to keep only those names beginning with an underscore, i.e. only the spot market dataset names. The names are sorted in descending order and "SET' into another DATA step. This step returns immediately for observations one through three. For each dataset name after the third, SAS statements are written to another temporary file to copy the SAS dataset to the mass storage file and delete it from the disk file. These statements are executed using the "XINC" statement. The ERRORABEND option is used to ensure that a dataset is not deleted from the disk file if there are problems copying it to mass storage. No problems have been found to date.

Selecting and Allocating Spot Coal Offers

A. General

Using the computer to help select spot coal offers and determine where they should be shipped is the original and the biggest motive for entering the data. Multi-million dollar spot coal purchasing decisions must be made every month in only a few days. For example, over $16 million worth of coal was ordered on the spot market for January 1983 delivery. Spotplus makes the procurement process much easier.

Three methods of selecting and allocating offers have been used: manual selection from a list ranked by cost on a per-million BTU; computer selection using linear programming to find the optimum solution; and computer selection using an algorithm that mimics a simple manual method.

B. Manual Selection

The user selects an option which causes a background job to be submitted. The delivered cost on a cents per million BTU is computed for each offer for each power station. The data is sorted by station and cents per million BTU and printed by station. The variable "NUMBER" is set to the original observation number so the offer can be easily located or referred to in the original dataset. Note that if an offer is selected for one power station, it must be crossed out on the lists for the other power stations. After the decisions are made, the original dataset is edited to indicate which offers were selected and where the coal will be shipped.

Computing costs on a cents per million BTU basis accounts for differences in heat content (although not completely). It does not account for other very important coal properties such as sulfur, ash and moisture content. Thus, it is not a simple matter of selecting the lowest cost coal. The decisions must be made by engineers who are familiar with the power station requirements, the effects of each quality parameter on each generating unit, and the coal vendor's ability to perform.

Allocating coal to minimize transportation cost is too complex to be done manually because there are millions of possible combinations. Therefore, the decisions made using this method might not always be the best possible.

C. Linear Programming

A linear programming model was developed to help find the optimum solution. This model was developed by Mr. Arthur Lunn and is accessed using a different command list which uses SPF panels for communication with the user and FORTRAN for the analysis. Coal quality is accounted for by establishing maximum and minimum values for quality limits allocated to the second station. A solution is found that satisfies the station requirements at minimum cost. After careful review, the purchase decisions are input to the Spotplus dataset.

Merely setting maximums or minimums does not completely account for quality. For example, a unit that is said to tolerate up to 10% ash can still use coal with 11% ash although it would mean increased maintenance costs and increased oil consumption due to reduced availability of the coal unit. If these costs could be expressed as a function of ash content and added to the delivered cost, then the coal could be considered along with the lower ash coals. Similarly, coals with ash contents lower than the maximum could be properly credited. These factors must be accounted for manually until these quality cost equations are developed.

Another area for improvement would be to optimize the quantity to be purchased for each station. Currently, the deliveries for each station are input to the model based on maintaining a certain number of days supply.

D. Simplified Method for Checking

Another automated selection/allocation system was developed by Mr. Lunn to check or backup to the linear programming model. The lowest cost offers that are within the quality limits are allocated to the first station until its need is met. The lowest cost remaining offers within the quality limits are allocated to the second station until its need is met. The process is continued until all power station needs are met. This will yield a total cost that is no lower than the linear programming solution if the linear programming model is operating correctly.

Whatever method of selecting and allocating offers is used, it must be under the close
supervision of an engineer who understands the underlying assumptions and limitations of the system.

Generating Reports

A. General
Spotplus generates several reports, some for the user alone, others for company-wide distribution. When the user selects a report option, she is prompted for the month and year of spot coal delivery, the report destination and the number of copies. The command list uses the TSO "EDIT" command to alter and submit for background execution the appropriate member of a partitioned dataset with the JCL and SAS statements necessary to produce the report. The appropriate jobcard is determined by calling another command list which accesses a dataset with a jobcard for each user.

B. Coal Ordered and Expected Report
The "Coal Ordered and Expected" report is used to indicate what coal was ordered and where it will be shipped. It is used by our Power Supply Department to determine the marginal cost of generation at each unit, by the power stations, and by our Accounts Payable Department. Unlike the other reports, the Coal Ordered and Expected report is written to a dataset. This dataset may be edited to make minor adjustments or to add footnotes. If the edit option is selected, the SFP ISPEEXEC function is used to enter the SPF edit mode without the need for any additional option menus or for the user to specify the dataset name.

C. Virginia Coal Report
The "Virginia Coal Report" is a special purpose report required by the Vice President - Fuel Resources. The report is in memorandum format and is printed on white unlined paper with a character set that looks like typewriter output (P11 character set on an IBM 3800 laser printer). The memorandum is signed by the Manager - Fossil Fuels.

D. Other Reports
A report is also generated for each dataset so the user can verify that the data was entered correctly. This includes spot market data, contract data, and freight rates.

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