# QUALITY COAL FOR ELECTRIC UTILITY USE

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## Introductory Remarks

Within the past two months, the National Coal Association has published a new forecast for the U. S. coal industry.

In its preface, Gene Samples, Chairman of NCA and Chairman and Chief Executive Officer of Consolidation Coal stated:

"Renewed interest in coal has given new impetus to the nation's coal producing industry. Its leaders see an opportunity to help return the United States to the energy leadership role that it once enjoyed . . . "[1]

He went on to qualify that statement by saying:
"To what extent this forecast is realized depends on many factors, not the least of which will be how steadfastly our country maintains its commitment to seek a long-range solution for today's energy problems."[1]

The new forecast projects electric utility coal consumption (Exhibit 1) to rise from its present level of just under 600 million tons per year to a "most likely" level of 868 million tons by 1990 and just over 1 billion tons by 1995.[2]

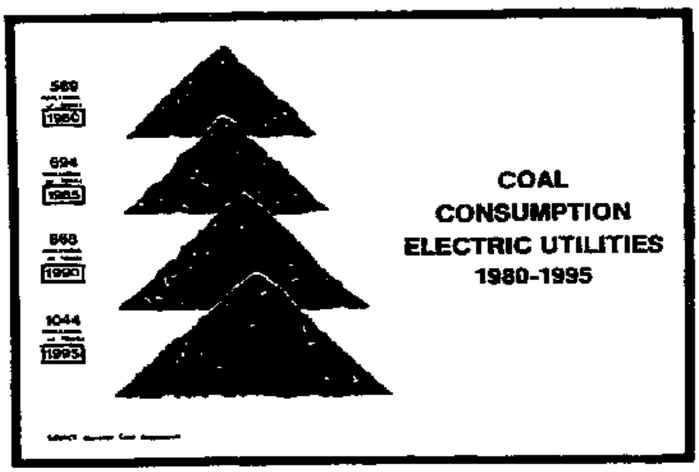


Exhibit 1

Whilst these forecasts appear to be reasonable, the question arises as to what segments of the coal industry will benefit from these increases as the utilities become more selective in the qualities of coal they will require.

We are on the verge of a major catharsis in the marketing of coal. A short 12 years ago, utilities could purchase just about any steam coal for $5 per ton to burn in generating stations built for $100 of capital investment per kilowatt of installed capacity. Today, depending primarily upon sulfur content, coal will sell from $20 to over $40 per ton and new generating stations cost in excess of $1,000 per kilowatt. We are told that some new stations coming on line later in this decade will cost well in excess of $2,000 per kilowatt of installed capacity.

Within the framework of these new economics, it is essential that the utilities squeeze every ounce out of their existing, lower-cost assets. And, with coal prices at a much higher plateau, the incremental costs of securing a higher-quality, more consistent coal is not overly significant.

The successful marketer of coal in the future will be the guy who thoroughly understands the economics of coal burning from the utilities' perspective, the guy who can totally integrate his thinking to include the economics of coal production, preparation, transportation, combustion and ash handling. He must also understand environmental control.

In short, he needs to understand what we call the total Coal Energy System. That System extends from the coal seam itself, with its complex chemical and mineral make-up, to the burning of the coal in the boiler and disposal of the ash residue, to the final cost at the power station busbar for the electricity generated.

From the mine face to the boiler, coal energy follows a path which, at each step affects the price, the quality or both:

- The Mining Method -- It might be required to take some top or bottom reject material to carry out the mining plan or operate at an economical rate. Partings in the seam could make it necessary to mine some clays along with the coal. Different face equipment produces various size consists. Different extraction methods yield different qualities.

- Mine haulage -- Free fall through chutes and silos can reduce the size consist making the raw coal product more difficult to handle and also affect the operation and economics of the wash plant. If the minus 28-mesh fines are discarded as reject, the size degradation experienced in mine haulage can result in a larger yield loss with valuable coal being dumped on the tip.

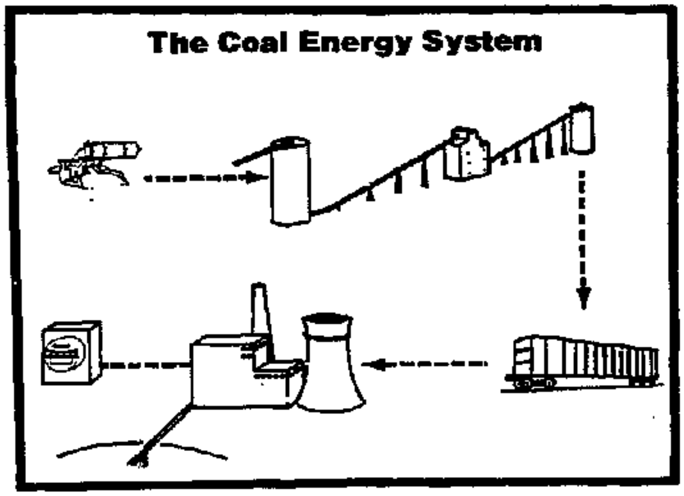


EXHIBIT 2

- Coal Preparation -- The design and operation of the wash plant is predicated upon the washability of the coal coming from the particular seam and the amount of degradation which occurs from the mining process and the haulage into the plant. Customer requirements for quality also dictate the thoroughness of washing and the circuits which will be required to produce a marketable product.

- Transportation -- The costs of transportation from the wash plant to the power station are difficult to predict over the long term and can have a major effect upon the delivered cost. A mode of transportation which is economically acceptable in today's market might become cost prohibitive five or ten years into a contract term.

- Combustion -- The key link is the way the coal fires in the boiler. Ash, moisture, sulfur, grind, base/acid ratios, and the physical and chemical characteristics of the elements and minerals in the ash are all variables which can affect the ultimate performance in the boiler. The presence, absence or variability of such constituents can make a major impact upon the cost of producing the steam to generate the kilowatthours.

- Ash Disposal -- The amount of ash to be handled and disposed of is in direct relationship to the amount of ash which is in the delivered coal. The ash pit is an important part of the overall Coal Energy System equation in determining the most appropriate balance of costs.

- Environmental Systems -- The quality of coal a generating station can burn is dictated in part by the specific environmental limitations established for a generating station. The reliability of the various links of the Coal Energy System chain is critical in assuring continual compliance with established standards.

- The Busbar -- The primary benefit of approaching coal burning from the Coal Energy System perspective is providing an analytical tool which can be used to help achieve the lowest possible cost per kilowatthour produced. This can not be achieved by looking at coal mining in isolation to transportation. Or, by evaluating coal preparation in isolation to firing the coal in the boiler. The objective is to achieve the desired results through total coordination of all links in the chain.

The integration of thinking and analysis, from the coal face to the busbar, will lead to a very elementary conclusion -- buying the cheapest ton of coal does not, of necessity, mean producing the cheapest kilowatthour of electricity.

There was a time when utilities would buy just about anything to burn in their boilers. The met market demanded and received the best product. The stoker and industrial market required a fairly good coal and the utilities would take what was left.

Today, utilities are becoming more selective in what they buy. The coal must meet the environmental restrictions. It must be of a quality which will improve plant performance and give rise to the greatest possible return on investment.

In addition, that quality should be consistent to allow the plant operator to predict, on a continuing basis, what he is feeding his boilers.

## The Utilities' Demand for Quality Coal

One of the primary concerns of coal-fired utilities today is a decrease in generating unit performance.

The April 29 issue of Public Utilities Fortnightly carried an article by Marie Corio, a senior consultant at NERA (National Economic Research Associates, Inc.) addressing this subject. She said:

> "The performance losses from decreased unit efficiency can be significant. For example, in places where losses in coal-fired generation are replaced by oil-fired generation (elsewhere on the System) every one percentage point decline in equivalent availability for a single 500-megawatt unit costs ratepayers over $1 million per year."[3]

The study by NERA that Ms. Corio is referring to traced the performance of large base-load coal units for the period 1970 to 1977. The sample of over 80,000 megawatts showed a decline in availability that was equivalent to 20 new 500 megawatt units. At current construction costs, she estimates the industry would have to raise $8 billion to replace those efficiency losses.

The question must be raised as to what contribution a consistent, high-quality coal could make toward reversing the decline in coal-fired unit availability?

The article by Ms. Corio used a chart showing a significant drop in unit availability for the period 1970 to 1977. In previous discussions on the importance of quality coal, I have used a similar graph (Exhibit 3) which showed a drop in unit availability from 78% in 1968 to 63% in 1977. I superimposed upon that graph the BTU quality of coal delivered to major coal-fired steam plants and that deterioration in BTU quality closely paralleled the availability curve.

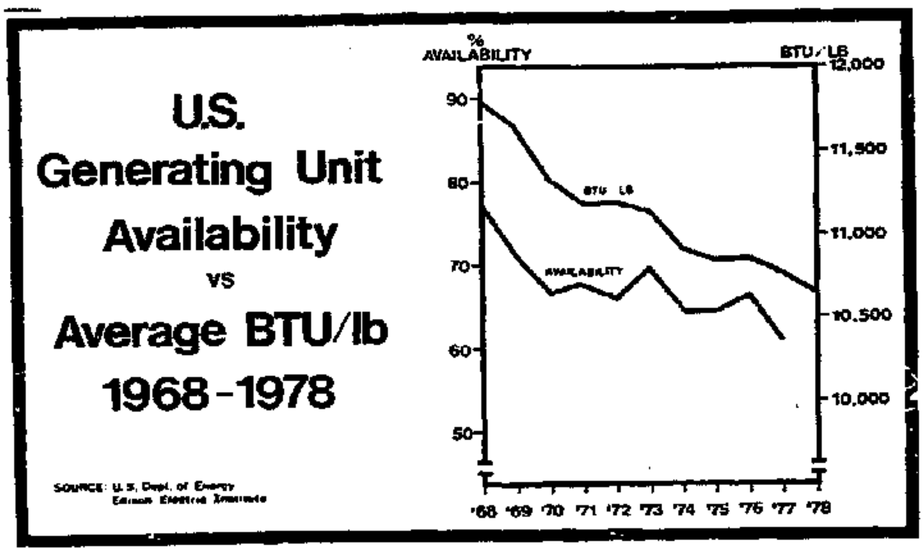


Exhibit 3

To get more specific, (Exhibit 4) we plotted the same two curves for one of AEP's 800 megawatt units for the years 1971 through 1975 and found a very similar parallel.[4]

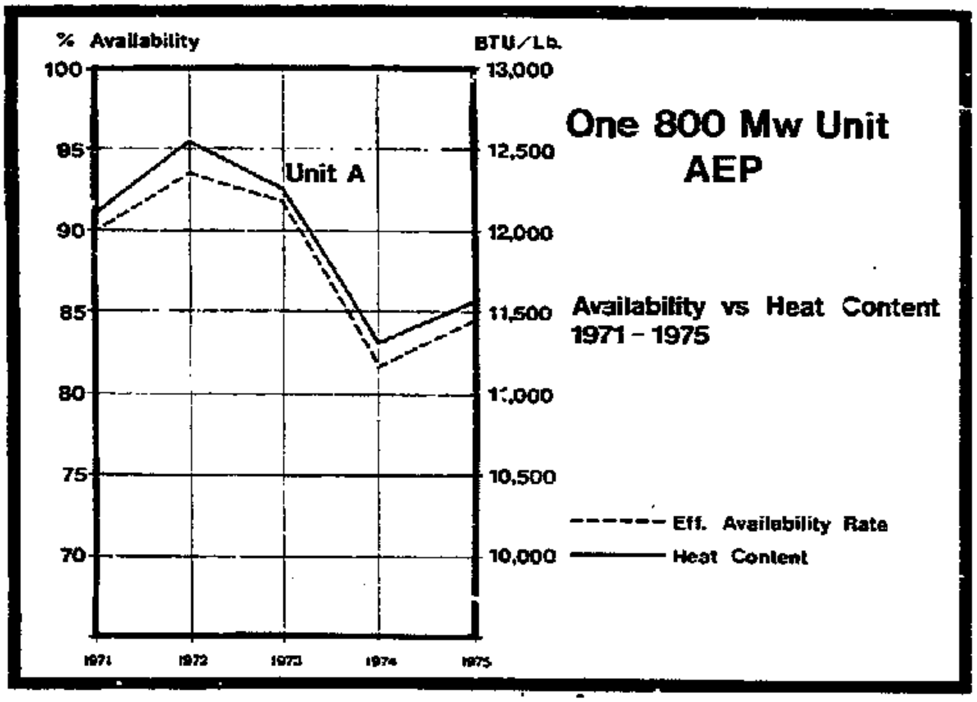


Exhibit 4

Other coal-burning utility systems and organizations have been studying the relationships between coal quality and boiler performance. The findings support each other.

A report by TVA's Division of Power Production attests to a surprisingly close correlation between coal ash content and boiler forced-outage rates. (Exhibit 5) As the ash content increased from 1963 through 1977 from just under 13% to over 17%, the forced-outage rate went from under 2% to 9%.[5] It should be noted that operators experience a delay between the time increased ash is introduced into the boiler and the forced-outage rates increased. Conversely, there will be a time-lag in getting the benefit of reduced forced-outage rates following the introduction of a lower ash coal.

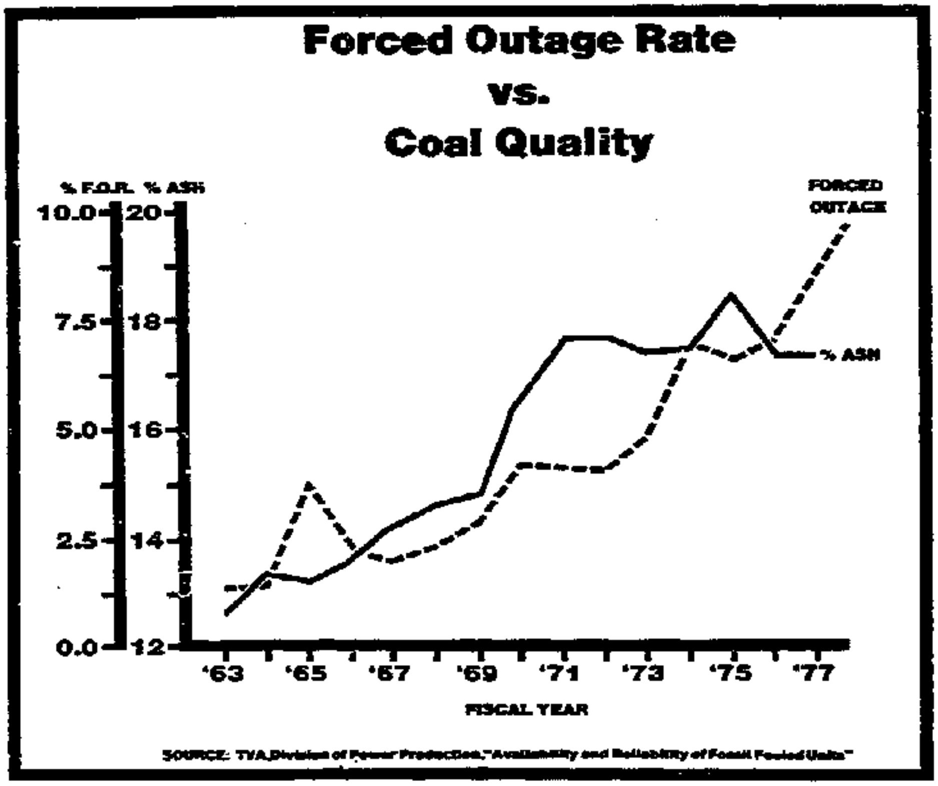


Exhibit 5

A study conducted for the U.S. EPA in 1980 by PEDCO, looking at the benefits associated with the use of physically cleaned coal in generating stations, stated in its abstract:

> ". . .the total of all of the benefits addressed in this report exceeds the cost of cleaning the coal. In a typical case the cost of coal cleaning is $4.85 per ton of cleaned coal, whereas the total benefits associated with the cleaning of the coal are $7.20 per ton of cleaned coal."[6]

There is growing evidence in the available literature that feeding quality coal to utility boilers yields an economic benefit in addition to providing a substantial degree of environmental improvement in terms of sulfur-dioxide reduction.

## Quality Coal Through Comprehensive Coal Cleaning

The AEP System has opted for comprehensive coal washing as a means of achieving compliance with environmental restrictions, where appropriate, and to increase boiler performance.

We accept that the one true measure of economic performance is the cost per kilowatthour at the busbar, as discussed earlier -- not just the cost of coal, nor the cost of capital, plant operations and maintenance, ash handling, or transportation in isolation. We must judge ourselves upon the amalgam of all these factors.

Integrated planning, analysis, and operation are all critical to the economic success.

At AEP's affiliated coal operations, we are comprehensively washing coal. The nine wash plants currently operating have a combined hourly throughput of 9,700 raw tons per hour. The performance of that washed coal in the boilers where it is used has demonstrated to our satisfaction that for AEP, the burning of a consistent, high-quality coal is cost effective.

In support of that assessment (Exhibit 6), it is appropriate to point out that AEP's customers paid an average of 3.87 cents per kilowatthour in 1981 compared to a national average which is estimated to be 5.32 cents.

An example of the effect of fuel quality on unit availability and performance can be demonstrated at our Tanners Creek Generating Station in Indiana.

Prior to 1973, Units 1 through 3 were fired with a high-sulfur, Midwestern bituminous coal. In 1973, due to environmental considerations, the fuel supply was changed to a low-sulfur, bituminous, run-of-mine coal produced at the company's

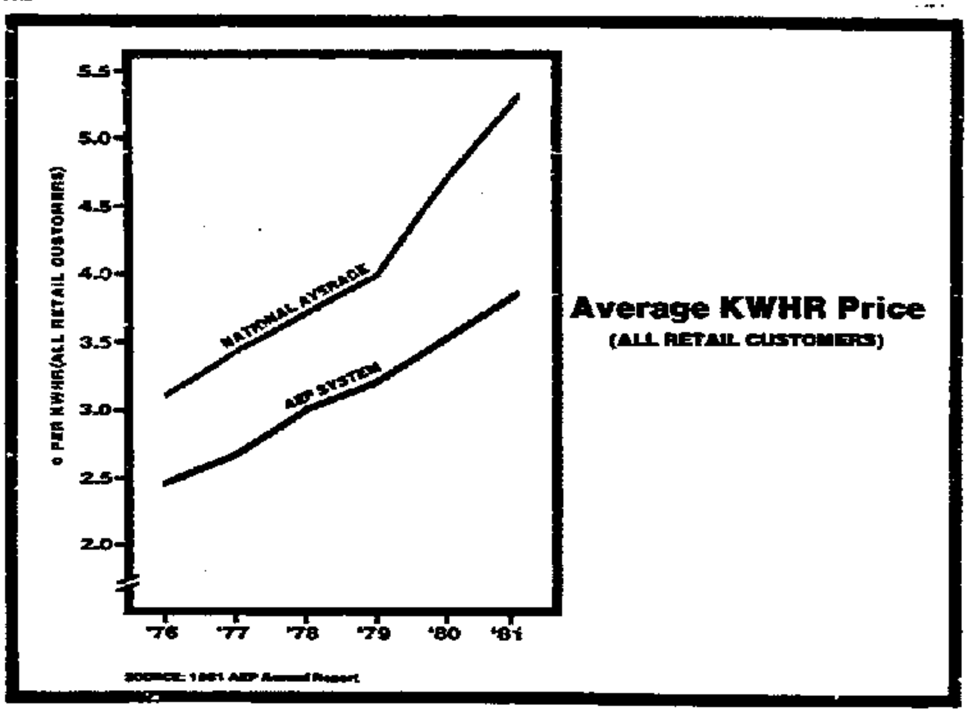


Exhibit 6

affiliated mine in Utah. During the period of 1973 to 1976 the units experienced a significant decline in unit availability due to the high ash content in the fuel.

**Tanners Creek Plant**
**Coal Quality Comparison**

| | Pre 1973 | 1973-1976 R.O.M. | '79-Present WASHED |
|---|---|---|---|
| **PROXIMATE COAL ANALYSIS** | | | |
| Moisture % | 10.9 to 11.2 | 8.7 to 6.9 | 8.5 to 9.0 |
| Ash % | 13.0 to 13.4 | 10.5 to 18.5 | 7.9 to 8.2 |
| Btu | 10,800 to 11,000 | 10,880 to 11,825 | 12,200 to 12,500 |
| Sulfur % | 3.5 to 3.75 | .57 to .63 | .45 to .55 |
| **UNIT OPERATION** | | | |
| Effective Availability % | 80.8 | 70.3 | 85.8 |
| Effective Forced Outage Rate % | — | 22.4 | 8.5 |
| Pulverizer Life Hrs. | 11,000 | 8,500 | 13,400 |

Exhibit 7

A program was initiated to construct a comprehensive coal-cleaning plant at the Utah mine, and by 1979 the three units were being fed a fully-washed product.

The ash was reduced (Exhibit 7) from a range of 10.5/18.5 to 7.9/8.2. Effective availability rose from 70.3% to 85.8%. The effective forced-outage rate dropped from 22.4% to 8.5% and pulverizer life was extended from 8,500 hours to 13,400 hours.

At our Muskingum River Generating Station in Ohio, we introduced a fully-washed coal in 1980. The coal from our Muskingum mine, located just 4½ miles from the plant was yielding, in its partially-washed state, an $SO_2$ level ranging from 8.3 pounds per million BTUs to 12.5 pounds. In the raw state, prior to washing the coarse fraction in a baum jig, the coal would yield $SO_2$ emissions ranging from 10 pounds per million BTU up to 23.8 pounds.

By comprehensively washing the coal we could reduce the emission levels to less than the proposed emission standard of 8.6 pounds.

To the existing jig circuit (Exhibit 8), we added heavy media cyclones and froth flotation with the clean product from the cyclones dewatered by centrifuges and the fine coal dewatered through string drum filters.

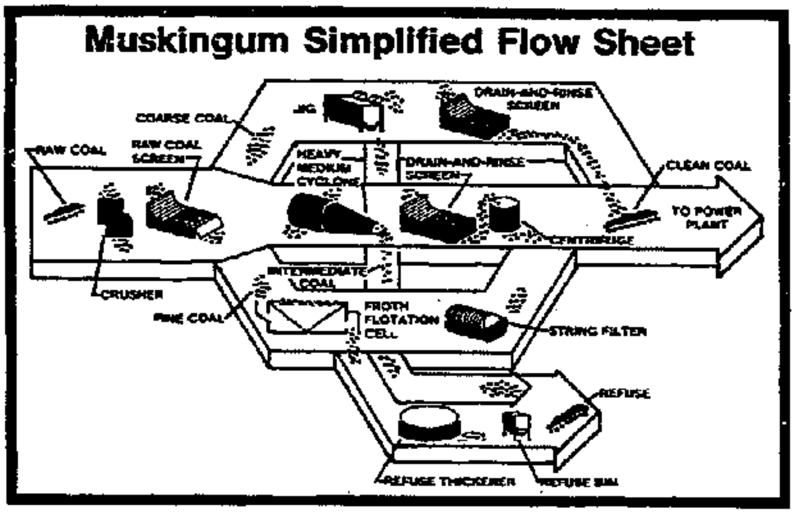


Exhibit 8

This comparison (Exhibit 9) of qualities before and after show the improvements that were made. A 7% decrease in ash, a ½% decrease in sulfur content, and a 1,000 BTU improvement. The important aspect is the improvement in consistency. The variability in ash is now only 3% as compared to 8%. The BTU range dropped from a swing of 1,200 BTUs to only 400 BTUs.

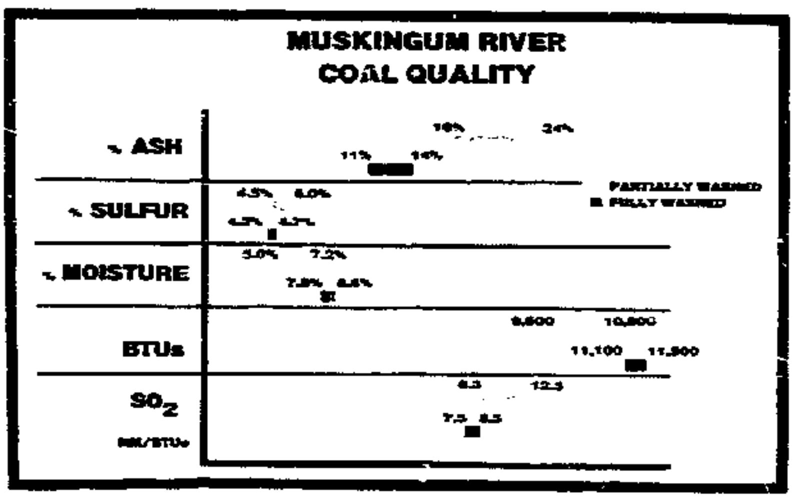


Exhibit 9

As a result of introducing fully-washed coal, along with some modifications made in the furnace wingwalls, the Company was able to increase the rating for one unit by 50 megawatts.

Whilst it is too early to quantify all the economic advantages of going to fully-washed coal, we can point out some of the savings.

The addition of 50 megawatts to System capacity has a value, based upon replacement cost, of $55 million in capital cost or an estimated annual owning cost of $13.7 million.

To meet environmental regulations we had three options:

- o install scrubbers;
- o switch fuels; and
- o comprehensively wash the existing supply.

Scrubbers would cost on the order of $214 million for this plant, or some $45 million per year to own and operate. This equates to some $15 per ton of coal equivalent.

Or, we could acquire an estimated 500,000 annual tons of low sulfur coal at a premium cost of $10 per ton, as a blender with the existing supply. Adding the cost of developing adequate rail facilities to bring that coal in would be an additional $10 to $12 million per year penalty. Or, an extra cost equating to about $8 per ton.

The Company selected coal washing as the most cost-effective compliance strategy to meet the mandated 8.6 pounds $SO_2$ per million BTU emission standard. Adding the fine coal cleaning circuits to the existing washplant would incur annual incremental costs on the order of $9,200,000 (in 1981 dollars) or about $3 per clean ton.

The comparison of delivered costs (recast into 1981 dollars), on a cents per million BTU basis, for the last two years prior to the implementation of full coal washing and two years since is as follows:

Cost per million BTUs delivered to the power station, recast into 1981 dollars (Exhibit 10) are as follows:

| | | |
|---|---|---|
| Pre-modification | (1978 | 148.26¢ |
| | (1979 | 147.87¢ |
| Post-modification | (1980 | 148.47¢ |
| | (1981 | 152.22¢ |

As a result of fully washing the coal, we were able to more efficiently carry out the mining plan which gave us a net increase in coal costs of only 4¢ per million BTUs, or less than $1 per ton.[7]

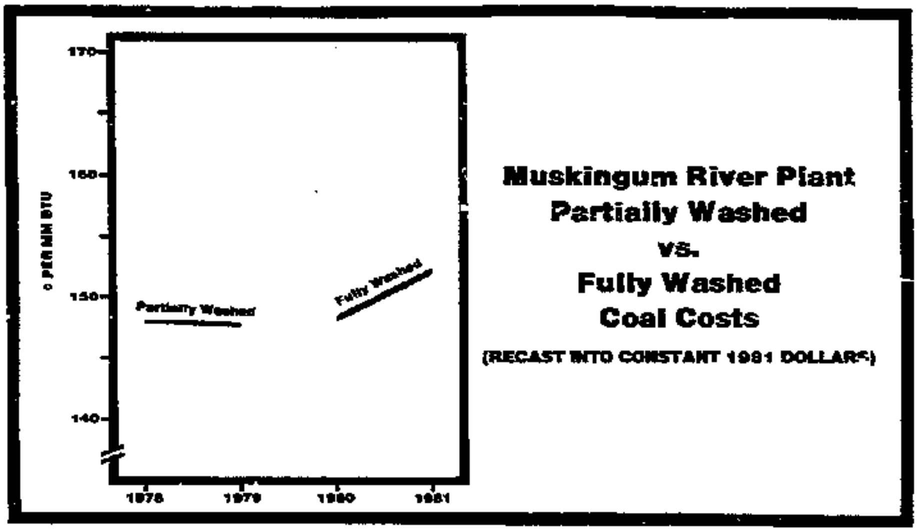


Exhibit 10

The Tanners Creek and Muskingum River examples of the impact of washed coal upon boiler performance are but two of many which can be found on the AEP System.

One of the problems associated with burning a high-ash coal, or a coal with extreme fluctuations in ash, is the build-up of soot and slag in the convection pass.

The AEP System has used, on occasion, a test boiler facility to determine the burning characteristics of various seams of coal, both in a washed and unwashed state. In one such test, we examined the Ohio #6 coal. Exhibit 11 shows that that coal, in its raw state, would block the convection pass very quickly and we would have to use the soot blowers every three hours to keep the boiler operating. In a washed state, the convection pass stayed open and we did not have to blow until after twelve hours of operation.

Traditionally, coal producers and utility consumers have evaluated coal quality on the basis of the ash, sulfur, moisture, BTUs, and grindability. More recently, utilities have been referring to a nomograph, similar to the one shown here (Exhibit 12) in an attempt to predict the slagging potential of various coals.

In this nomograph exercise, certain base elements are plotted against acidic elements to arrive at a base/acid ratio.

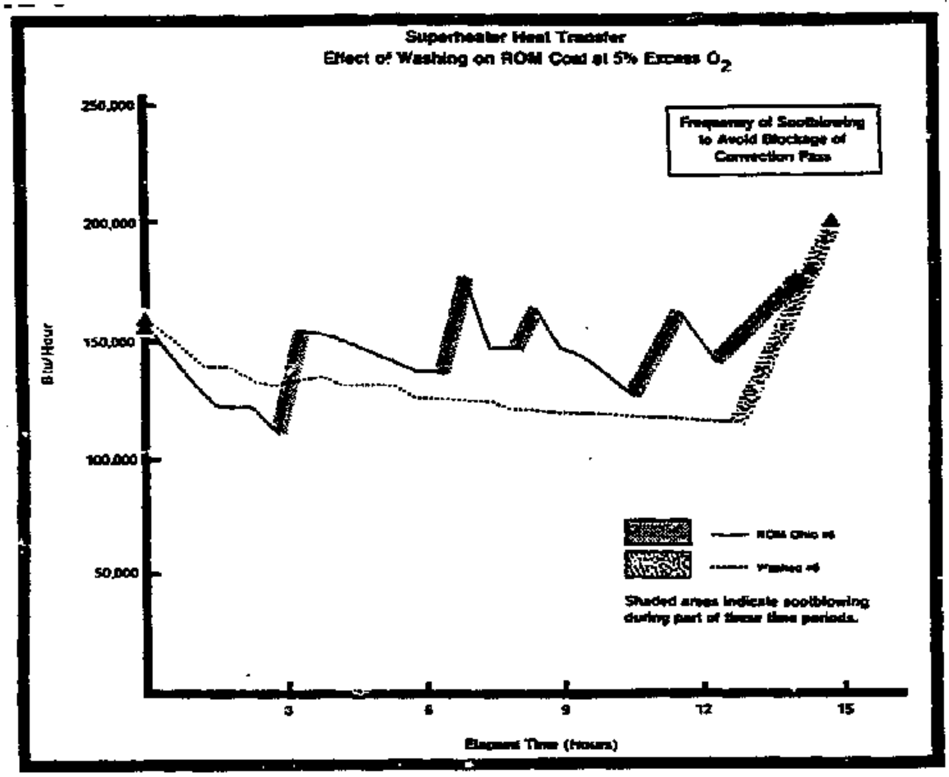


Exhibit 11

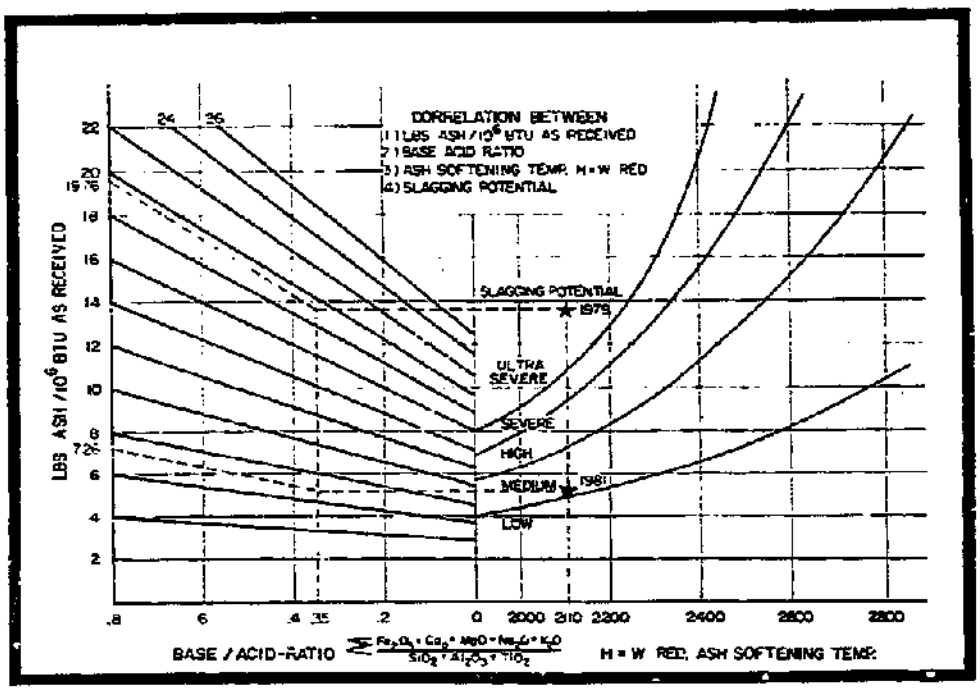


Exhibit 12

Plotting both this ratio and the ash softening temperature against the pounds of ash per million BTUs give a general indication of how much slagging could be expected in the boiler.

Over the years, numerous theses for predicting the behavior of coal ash under furnace conditions have evolved, such as this nomograph. Most have shown some validity -- at least under certain sets of conditions and for specific seams. However, experience in working with a wide variety of seams, can lead to the conclusion that no one thesis can be applied universally.

If the argument can be accepted that utilities must make every effort to optimize the operation of their boilers, it becomes essential to know the precise details of the ash chemistry of the coals being burned. The interaction of various ash elements, at the wide range of temperatures to which they are exposed and the potentials of those elements to cause slagging and fouling can cause significant damage.

It is suggested that the finite detail with which we have designed boilers to extract more and more usable energy from a pound of coal has not been accompanied by similar detailed studies of the coal product fed into those highly engineered machines.

In attempting to increase the performance and availability of our boilers, we need to look further than just providing a low-ash, high BTU product. There have been occasions when we have, through comprehensive washing, reduced the ash content well below what would be considered acceptable limits, only to find that the slagging problem has not been solved and at times aggravated. Conversely, we have taken high-slagging coals, reduced the ash and ended up with a satisfactory product.

The importance of studying the chemical properties of coal ash and the subsequent physical changes those chemicals under-go in the high temperature environment of a modern boiler cannot be overemphasized.

Such study becomes even more critical when looking at the direct firing of a coal/water mix or a coal/oil mix. Although I make no claim to be knowledgeable on either of these potentials, I none-the-less feel it imperative upon the coal and utility industries to know and fully understand the characteristics of both the combustible and inert fractions of the coal and the interaction of those fractions during and after combustion. Further, we must develop the technology and expertise necessary to understand what we are burning to ensure a highly-controlled, consistent product which can be compared to the traditional liquid fossil fuels.

## Quality Coal and Environmental Control

At the present time there is considerable debate in the U.S. Congress over the mandatory renewal of the Clean Air Act. The primary issue that is in the public eye is something called "acid rain."

Whilst today no one has clearly defined "acid rain" or, with any degree of technical reliability, identified what might be causing the problem; great pressures are being exerted to immediately arrive at a legislative and regulatory solution.

The Mitchell Bill in the U.S. Senate would propose to reduce sulfur dioxide loadings of the atmosphere by some 10 million tons over the next ten years, by placing severe emission restrictions upon the coal-fired generating stations in 31 impact states east of the Mississippi. Two weeks ago, the Senate Environment Committee, in a 15-0 vote, approved such an amendment to the Clean Air Act. Those of us here today who have read the available literature on acid precipitation must come to the conclusion that such drastic action is premature.

The cost of this mandated requirement would be prohibitive to the coal-burning utilities and an economic disaster to those utilities' ratepayers.

For the AEP System, which burns well over 40 million tons of coal per year, the cost impact of complying with the Mitchell Bill would be over $7 billion in capital and annual costs of $2 billion.[8]

The resulting impact upon our customers would be a 63% increase in electric rates.

On a national basis, the annual costs of the Mitchell Bill have been estimated to be far in excess of $8 billion per year.

In addition to the costs of complying with this drastic legislation, one must consider the time which would be required to achieve the anticipated results. How many years would it take the utilities to arrange for the necessary fuel switching and cancel existing contracts?

How much economic disruption would be created for the nation's coal industry? What would be the costs of new mine development to secure the vast quantities of low sulfur coals required? Who would suffer the loss of return upon investment from the many existing higher-sulfur mining operations which would, of necessity, be idled?

Does the nation, in fact, have the manufacturing capacity to produce the number of scrubbers required to meet the demand created by the Mitchell Bill mandate? Or, how many years would it take to gear up to meet the demand?

And, a more basic question. Are we satisfied that scrubbers are reliable enough to do the job?

The entire question of environmental clean-up needs to be reviewed from a dispassionate posture, putting aside the personal biases and prejudices of the vocal minorities on both sides of the issue. It needs to be looked at from a broad perspective, taking into account the gross impact upon the health and welfare of the nation, properly weighing both the environmental and economic costs and benefits.

The President's Council on Environmental Quality issued in its latest report to the Congress, stated that since 1974 we have affected a 24% reduction in $SO_2$ emissions.[9] During the past decade we have experienced a 55% reduction in suspended particulates and a 90% reduction in carbon monoxide emissions from automobiles. Progress is being made and there have been measurable air quality improvements in and around our major cities and metropolitan areas.

If we accept that more can and should be done, it is suggested that it be done in the most cost-effective manner. In these days of rampant inflation, coupled with a national recession, we need to minimize the effect upon an already hard-pressed population. We are moving in the right direction and we should keep moving at a responsible pace, not by quantum leaps which compound our economic problems.

From recent studies by governmental bodies, utility specialists and independent consultants, it appears that substantial gains can still be made in reducing the $SO_2$ emissions by burning a higher quality, more consistent coal. And, from the experiences of AEP and other utilities, could this not be done with essentially no cost impact upon the utility ratepayer, considering the examples presented earlier?

Today, there are 250,000 megawatts of installed coal-fired capacity in this country, burning nearly 600 million annual tons of coal. Of that capacity, it is reasonable to say that only 25 to 30 percent of the coal burned is at its maximum quality level on an economic basis. It is logical to assume, from the 450 million tons, of coal which is not of the most appropriate quality or thoroughly washed, $SO_2$ could be reduced between 25 and 30%. By removing 25% of the $SO_2$ (stated in pounds per million BTUs) from the 75% of the coal which could be comprehensively cleaned, we could see a reduction in $SO_2$ atmospheric loadings from the present 16 million tons down to 12 or 13 million tons. And, would not this give us a very responsible degree of improvement?

This could be accomplished in a fairly short time frame without disrupting present supply sources, without causing economic harm to the present coal-producing regions of the nation and, I repeat, at little or no cost to the nation's consumers.

## Coal Quality and World Utility Markets

The International Energy Agency (IEA), an autonomous body within the framework of the Organization for Economic Cooperation and Development was formed to establish and implement a cooperative international energy program. It, in turn, established the Coal Industry Advisory Board to assist in implementing the IEA principles for action on coal. At the Tokyo Economic Summit in June of 1979, the organization issued the following declaration:

> "We pledge our countries to increase as far as possible coal use, production, and trade, without damage to the environment. We will endeavor to substitute coal for oil in the industrial and electrical sectors, encourage the improvement of coal transport, maintain positive attitudes toward investment for coal projects, . . . and maintain, by measures which do not obstruct coal imports, those levels of domestic coal production which are desirable for reasons of energy, regional, and social policy."[10]

As a member of the Coal Industry Advisory Board, I have been involved with several task forces examining the potential for expanded coal use on a world-wide basis and identifying the various constraints which have, to date, deterred that expanded use.

As I have participated in the task force sessions and digested the comments and concerns voiced by the various international representatives, I have come to the personal conclusion that many of the problems could be moderated if the major coal exporting nations -- the U.S., Canada, South Africa and Australia -- were offering a higher quality, more consistent product and the importing nations accepted the modest incremental increase in price.

You hear, on the international front, many of the same concerns voiced here in the domestic market. They are faced with stringent environmental restrictions, are concerned about full and economic utilization of their power station assets. They discuss air problems associated with ash disposal, and voice concern about the increased complication of coal firing as a substitute for oil-fired generation.

If the concept of the Coal Energy System and a totally integrated approach to coal makes sense here domestically, it makes more sense for the international market. Nations such as Japan and parts of the European Economic Community are land short. Ash disposal creates serious problems for them. Why not acquire a fully-washed coal which could cut the ash disposal problems in half?

At the same time, a reduction in ash could cut the costs of shipping coal around the world. If the total transportation costs from the western United States or Canada to Japan is at least $30 per ton, a reduction in ash from a 20% level to something on the order of 10% would save about $3 per ton on shipping costs. For a 1,000 megawatt unit burning 2½ million tons per year, this would mean a cost reduction of $7.5 million on an annual basis. The reduction in shipping costs, alone, would come close to covering the incremental costs of fully washing the coal. And, the bonus would be the savings in reduced ash handling costs and improvements in boiler availability and efficiency as demonstrated by the two examples shown earlier.

Generating station operators, familiar with operating oil-fired units, must have great difficulty in adjusting to coal-fired plants burning run-of-mine coal where BTUs can vary by 1,000 or more. They are exposed to sudden slagging and fouling and must contend with changing rates of feed to the pulverizers. Their problems can be greatly minimized by burning a fully-washed coal with narrow quality fluctuations and a predictable fuel fed into the boilers.

With domestic growth of the utility industry reduced to a projected compound rate of between only 1.9% and 3% up to the year 2000, we need to open up international markets to achieve the desired level of coal production predicted by Gene Samples in the new NCA coal forecast quoted at the beginning of this presentation. Selling the concept of clean, high quality, consistent coal could open up the market and provide both economic and environmental benefits on a world-wide basis.

## Summary Comment

The burning of a higher, more consistent quality coal appears to be the prudent approach for meeting the economic requirements for the utilities and resolving some of the nation's environmental concerns.

AEP's plant operating people have attempted to catalog potential areas of savings from burning a higher quality, more consistent coal.

Production cost savings:

- increase total generating capability;
- reduction in fuel usage;
- cleaner heat transfer surfaces;
- lower excess air;
- higher turbine cycle efficiency; and
- improved unit availability.

Reduction in maintenance costs:

- lower fuel handling costs;
- lower ash handling costs;
- reduced pulverizer wear rates;
- lower ash disposal costs;
- lower erosion rates; and
- less potential for furnace slagging.

High unit availability adds megawatts to the System's generating capability deferring the need to install new capacity.

There are many utility boilers in this country and world-wide burning what, in pit language, we call crap coal.

Even though that coal might cost a few dollars less per ton, does it not aggravate the busbar cost and increase our environmental problems?

I am not prepared to say that what is working for the AEP System will work for all utility systems. There are too many parameters and variables to look at and every case must be reviewed on its own merits. However, in the overall we believe that feeding boilers with a high, consistent quality coal tailored to the requirements of specific boilers will, in the majority of cases, be cost efficient.

One of the big advantages operators of oil and gas-fired generating units have is that that they can predict with a high degree of confidence the quality of fuel they are feeding into their boilers at any given moment. They can fine-tune their systems on the basis of that predictability and records show they experience a high level of availability with a minimum number of forced outages. Similar confidence could be achieved with a coal-fired unit by procuring a higher, consistent quality coal. In most cases this means washed coal.

The coal producer who recognizes the importance of coal quality, who can sit down with his utility customers and view the entire Coal Energy System in an integrated fashion, is the producer who will be making the maximum contribution towards our efforts of utilizing the vast coal energy reserves we have here in the United States.

The success of our nationwide effort to replace imported oil energy with domestic coal energy is dependent upon this integrated approach.

The pressures being exerted to develop synthetic fuels from coal is due, in part, to the problems associated with handling cumbersome coal with its wide-ranging impurities and its ash disposal problems. The more we can clean up coal, reduce handling costs, improve its burning predictability and minimize ash handling, the more acceptable it will be to ship around this country and the world as the primary and most cost efficient boiler fuel.

We have just begun to scratch the surface in developing cleaner, higher-quality coals.

We must keep the young, creative minds motivated to develop ways of further cleaning up our coals.

Will these active minds find ways of liberating sulfur from coal, and controlling all the ash chemicals which erode and eat away at boiler tubes?

I say they will, with the help of those of us who are struggling with the wide spectrum of coal energy problems on a day-to-day basis. Those of us who can spotlight the problems and develop the challenges.

If this nation is to achieve its goal of energy independence by the turn of the century, it must look to coal. The options are using coal in its present, solid state or as the product of a liquefaction or gasification process.

You heard, earlier in this keynote session, a discussion on synfuels technology. We must accept that the widespread use of synfuels, in the volumes required by the electric utilities, is still quite a few years down the road. And, we must also accept that the costs of synfuels, on a cents per million BTUs basis, will be much greater than the cents per million cost of coal -- even highly beneficiated coal.

It is suggested that synfuels rightful place in our energy supply scheme could be as a direct replacement for oil and gas and not as a substitute for coal.

If as much of our national energies were placed behind research on developing and perfecting the pre-combustion cleaning of coal as it has been placed upon the more exotic and esoteric energy theories connected with post-combustion cleaning, we would be much further down the road toward feeding our utility boilers a clean fuel against which the environmentalists, stockholders and ratepayers could not take exception.

And would not such an effort have had us much further down the road to national energy independence? We have been faced with two major energy supply crises during the past nine years. considering the unstable nature of the OPEC cartel, how long will it be before another crisis emerges?

We have a tendancy to be complacent, to feel the immediate problems will somehow subside and we can continue as before. In reality, the economic and social standard of living we thrive upon cannot continue without a reliable supply of energy over the long term. The quicker we can fully develop our coal resources and develop the types of coal products which can be compared to oil and gas, in consistency and quality, the sooner this nation will realize energy independence.

The universities and research centers of this nation would be well advised to concentrate their energies on developing advanced methods of cleaning up coal, starting from the fairly advanced stage already achieved in coal beneficiation. The partnership in such an effort should be the inquisitive young minds, the seasoned researchers and the practical engineers who are working within the industry on a day-to-day basis. With proper sensitivities, logical thinking and the capacity to understand the broader picture, i.e., the Coal Energy System, significant progress could be made.

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