NEW ENGLAND ELECTRIC COAL CONVERSION EXPERIENCE

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The New England Power Company - the generation and transmission subsidiary of the New England Electric System - has undertaken a major oil to coal conversion program involving six generating units totaling 1460 MW of capacity. The conversion of three units (1150 MW) has been completed at the Brayton Point Station in Somerset, Massachusetts and conversion of three units (310 MW) is underway at the Salem Harbor Station in Salem, Massachusetts.

A host of issues were involved in the decisions leading to the conversions and, today, I would like to discuss the principal issues and how they impacted on both the schedule and costs. Since the Brayton Point conversion is complete, I will also comment on our experience to date following the conversion.

CONVERSION PHILOSOPHY

At the outset we established two basic groundrules for our potential conversion candidates - the conversions had to be economic for our customers and the conversions had to be environmentally acceptable. Beyond the basic groundrules, we also made a commitment to high operating availability on coal and maintaining the capability to switch back to oil firing.

IMPLEMENTATION OF THE CONVERSION PHILOSOPHY

As we all know, establishing a philosophy is a relatively simple task - implementing it is a more formidable challenge. The key to assessing the economics is the definition of the scope and cost of the project and estimating the additional operating costs versus the potential or expected fuel cost savings. Definition of the scope of the project is heavily influenced by the original design of the units, the choice of coal specifications and - most important - the environmental requirements. To a significant degree, the three factors are interrelated. We recognized from the start that until the environmental issues were resolved no meaningful progress could be made so that became our initial focus. Despite a cooperative attitude on the part of our state and federal regional environmental agencies, the resolution of the environmental issues on the Brayton Point project covered the span of more than two years of concerted and intensive effort. From initial discussions to final State Implementation Plan approval covered a period of roughly four years! A not insignificant part of the delay can be attributed to the fact that coal had become a "foreign" fuel in our region of the country. The State air quality regulations were designed for oil firing - our regulators were not familiar with coal as a utility fuel - and they also realized that decisions made on the first coal conversion in the region would have precedent implications for future conversion proposals.

Since our oil burning regulations in Massachusetts were predicated on a most homogeneous fuel whose sulfur content could be finely controlled, it is not surprising that treatment of sulfur variability

in coal and averaging periods involved some fundamental changes in concept. In addition, how to treat coal sulfur variability in air quality modeling - particularly for the short term ambient standards - posed some regulatory problems - and led to a probabilistic modeling approach very similar to what is now labeled the "Ex-Ex" concept.

Because of an anomalous violation of the primary air standard for particulates during the early stages of our conversion discussions - a violation that was caused by heavy road sanding adjacent to a monitor and not associated with powerplant emissions - interest in particulate emissions in the region heightened. This, coupled with a perception that coal burning means smoky stacks, led to a particularly stringent particulate emissions limit for the conversion.

From my company's standpoint, one additional element in our environmental negotiations was a compelling issue - that we not face changes in the State Implementation Plan once we had committed major expenditures for the conversions. On this point, the state agreed to a "best efforts" agreement not to tighten the Implementation Plan limits for a period of ten years.

The simplicity of Table 1 belies the underlying effort in arriving at the environmental agreement for conversion of the Brayton Point Station. However, it represents the basis for a number of subsequent design and operating decisions.

TABLE 1

Brayton Point Coal Conversion Agreement

	Pre Agreement (Oil & Coal)	Post Agreement (Coal)
Fuel Sulfur	1.21#/MMBTU Maximum	1.21#/MMBTU 30 Day Average 2.31#/MMBTU 24 Hour Average
Particulate	0.12#/MMBTU	0.08#/MMBTU
Stability of SIP Limits	None	10 Yr. "Best Effort" No Tightening of SIP Limits

Once the environmental issues were resolved, coal specs and plant design requirements were solidified, and accelerated design and construction efforts commenced in June of 1979.

For the Salem Harbor conversion, the environmental agreement path was somewhat simpler - though complicated by existing plant stack downwash effects predicted by modeling. Since a new tall stack was incorporated in the conversion proposal, the coal conversion agreement differed from the Brayton Point agreement with respect to particulate emission limits. The particulate limit for Salem Harbor will remain at the oil limit - 0.12#/MMBTU. With the stack height more than doubled, the ground level particulate concentrations will be dramatically reduced - and considerably lower than if we had designed to the Brayton Point emission figure.

The economic analysis for each of the stations clearly demonstrated the economies of scale - even in a coal conversion. Table 2 illustrates the difference in conversion cost per kilowatt for the 1150 MW Brayton Point conversion and the 310 MW Salem Harbor conversion.

I hasten to point out, however, that conversion costs are very unit and site specific. While there appears to be an economy of scale, conversion costs of similar sized units can vary considerably.

Table 2

	Brayton Point	Salem Harbor
Coal Conversion Capacity	1150 MW	310 MW
Est. Conversion Cost	$190 Million	$100 Million
Est. Conversion Cost	165/KW	323/KW
Oil Displaced/Yr.	12 Million Bbls.	3.5 Million Bbls.

The crux of the economics issue, however, is the differential between coal and oil prices - and more precisely - what will that differential be over time. We concluded very early - after looking at a host of estimates from various sources - that there is no "right" answer. We have concluded that we have higher confidence in near to mid term differentials than in long term differentials - that they will support the Brayton and Salem conversions - and that getting the conversions completed as soon as possible,gives us the best chance at accruing savings for our customers.

Financing conversions has been the subject of much discussion - particularly in this era of high interest rates and utility stock selling below book value. For the Brayton Point conversion we used conventional utility financing and raised roughly 50% of the capital via lower cost pollution control financing. The Salem Harbor financing involves a more unique concept. Our regulators have approved what is called an Oil Conservation Adjustment which permits passing on a portion of the fuel

cost saving to the customer immediately and applying the balance to paying for the conversion. When the conversion cost is fully paid for, the full fuel cost saving flows directly to the customers.

THE BRAYTON POINT PROJECT

The Brayton Point project was originally estimated to cost $180 million. The project was authorized in June of 1979 with completion of conversion scheduled for March 1981 (Unit 1 - 250 MW); May 1981 (Unit 2 - 250 MW) and November 1981 (Unit 3 - 650 MW). To appreciate the scope of the conversion, Table 3 lists the breakdown of the capital cost.

TABLE 3

Precipitator Additions (Units 1-2-3)	$ 79 Million
Ash Handling (Units 1-2-3)	34 "
Coal Handling & Misc. Site Work (Common)	19 "
Conversion of Unit 3 from Pressurized to Balanced Draft and Misc. Boiler/Control Work	14 "
New Pulverizers (Unit 3)	24 "
Boiler/Instrumentation/Fans (Units 1-2-3)	20 "
	$190 "

Looking at the reasons for the major modifications:

(1) Precipitators - Collection surface was tripled with the addition of precipitator capacity added in series to the existing precipitators.

(2) Ash Handling - When these units burned coal in the 1960's, fly ash and bottom ash was sluiced to a large settling pond on site using salt water as the conveying mechanism. The installation of Unit 4 in 1974 occupied the area of the old settling basin. Beyond that, salt contamination of the ash would have made ash reuse or disposal difficult so we decided early to install dry ash systems.

(3) Coal Handling - The existing coal handling system was only marginally capable of handling our coal requirements in the 1960's when we burned a higher BTU and lower ash coal. The additional throughput coupled with more stringent fugitive dust considerations - and coal pile runoff collection and treatment - resulted in significant modifications.

(4) Conversion to Balanced Draft - Unit 3 is a supercritical 650 MW unit designed as a pressurized boiler unit. Furnace casing and duct leaks were tolerable on oil, but the added ash leakage on coal firing would lead to problems within the station - and a decision was made to convert the unit to balanced draft operation. Additionally, modifications were made in the burner management system to permit startup on No. 6 oil instead of No. 2 oil.

(5) New Pulverizers - Unit 3 - The existing B&W type CR-77 mills were replaced with B&W NPS-89 mills to improve reliability and to provide full load operation with one mill out of service.

(6) Boiler System Modifications - Units 1 & 2 - Because of increased gas flow on these units resulting from the quality of coal to be burned, the induced draft fans were replaced. Modifications were also made to the burner management system.

The final project cost is $190 million vs. the original estimate of $180 million. Unit completion dates were close to the schedule dates, and I should point out that we had a most rigorous schedule objective. We allowed 21, 23 and 29 months respectively for the completion of the three units - and these time spans included engineering, procurement, construction and startup.

While the project was a challenge - the real objective is completion and assessment of results. I view the results from these vantage points:

BENEFIT TO CUSTOMERS

In the past year - with only a portion of our conversions completed - the fuel cost savings in our System totaled over $60 million. On a fully completed conversion program - and based on the past twelve months coal/oil differentials - we expect an annual fuel cost saving of over $100 million.

ENVIRONMENTAL RESULTS

There is a common misconception that coal burning degrades the environment. Our results to date show just the opposite. SO_2 emissions on coal are some 20% lower than when the same units burned oil. Particulate emissions - based on performance tests - indicate emissions over 50% lower than similar tests on oil firing. The stacks are clear on coal firing. A significant portion of our coal ash is being used in daily landfill cover - replacing the use of gravel - and ash is gaining acceptance for its potential use rather than being viewed as a waste disposal problem. We have been able to point to the environmental benefit associated with the Brayton Point conversion.

PUBLIC ACCEPTANCE

We believe that the economic and environmental results - coupled with an active campaign to sell the public on the necessity of coal burning before conversion has helped immensely in paving the way for additional coal conversions now underway or planned in the region.

OPERATING RESULTS

Results on Units 1 and 2 have been very good thus far. The shakedown on Unit 3 - which underwent a number of extensive modifications - is proving to take longer than was the case on Units 1 and 2. However, we have every expectation that it, too, will prove to be a reliable coal burner.

THE SALEM HARBOR PROJECT

Authorization of the Salem Harbor coal conversion project in January 1982 triggered the commencement of design and procurement. On site construction started in June of this year and completion of conversion is scheduled for 1984 for Units 1 and 2 (80 MW each) and 1985 for Unit 3 (150 MW). The project cost is estimated at $100 million and the major cost components are as follows:

Gas Cleanup (Incl. ESP's/Stack)	$ 65 Million
Ash/Water Systems	13 "
Auxiliary Systems	11 "
Misc. (Incl. Boiler/ Fuel Handling)	11 "
	$100 "

I would point out some of the major differences between the Brayton Point and Salem Harbor conversions. The Salem project involves building a new, 440 foot, 3 flue stack to replace the 3 existing 150 foot stacks. At Brayton Point we added our new precipitator capacity in series with the existing precipitator. At Salem we are removing and replacing the existing - and aging - precipitators. Salem has no fixed coal unloading facilities, and we are not planning to install any.

A subsidiary of New England Electric is constructing a new coal fired, self-discharging coal collier - under a joint venture arrangement - and this new vessel will deliver the total coal requirements for Salem Harbor plus a significant portion of the annual Brayton Point requirements. The new ship is scheduled to be placed in service in mid 1983.

The other major difference between the two conversion projects is the very tight, urban setting of the Salem site. As a result, construction logistics are considerably more challenging at Salem Harbor than at Brayton Point.

CONCLUSIONS

Our experience at Brayton Point and Salem Harbor has left me with some impressions and conclusions that I hope will be of interest and benefit to utilities planning to convert to coal.

(1) Community relations are important - inform and condition your plant neighbors to what you plan to do - particularly in those areas that are not familiar with coal burning.

(2) Ensure that you have all environmental groundrules in place before committing to a major design effort. Air, Water and Ash controls will have a profound impact on your design and your costs.

(3) Expect the resolution of environmental issues to take longer than you believe is reasonable or necessary.

(4) Start developing the concept of ash as a resource well before you start producing ash - especially if disposal sites are scarce.

(5) Remember that retrofitting has many pitfalls - be especially mindful of equipment and system interfaces.

(6) Be alert to secondary system (e.g. compressed air, service water, electrical station service) margins. The additional loadings resulting from added coal related equipment can exceed the perceived margins.

(7) Avoid the temptation to correct all the plant's shortcomings in the conversion project.

(8) Beyond the capital costs for new equipment, be prepared for "one time" refurbishment costs.

(9) And when a Department of Energy official like Bob Davies says - "I'm here to help" - don't get nervous - because he most likely will help!

While these points may appear quite obvious, specific attention to them may prevent some unpleasant surprises.

Coal conversion has been and remains a high priority at New England Electric. We are pleased with the economic and environmental results achieved thus far and truly believe that our transition from oil based to a coal based generation will best serve our customers and our region in the years ahead.