MASTER

ANALYSIS OF ALTERNATIVE-FUEL PRICE TRAJECTORIES

Prepared for:

**Economic Regulatory Administration
U. S. Department of Energy**

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Overview

On December 24, 1980, the Economic Regulatory Administration (ERA) of the Department of Energy (DOE) published a final rule for calculating the comparative costs of using either imported petroleum or alternate fuels in a powerplant or industrial facility (45 FR 84967-85). This cost calculation is used to implement provisions of the Powerplant and Industrial Fuel Use Act (FUA) that relate to exemptions and prohibition orders. For example, the FUA provides for exemptions from the prohibitions on burning oil or natural gas in existing and new facilities when it can be demonstrated that the cost of using an alternate fuel "substantially exceeds" the cost of using imported petroleum.

In the final rule, ERA adopted a net present value approach to appropriately weight (with a discount factor) past, present, and future costs associated with using imported petroleum or alternate fuels. The net present value approach requires an estimate of future fuel prices over the useful lifetime of a facility, assumed to be forty (40) years for a new industrial installation. ERA published in its earlier notice of proposed rulemaking (45 FR 42109-212; herein referred to as the NOPR), an examination of long term fuel price forecasts from three sources: the Energy Information Administration (EIA) of DOE, Data Resources, Inc. (DRI), and Wharton Econometric Forecasting Associates, Inc. (WEFA). Then the ERA sponsored this study to:

- o acquire and analyze updated long term forecasts from EIA, DRI and WEFA

- o identify and compare additional fuel price projections published by other academic, public and private institutions, and
- o determine the impact of future fuel price differentials in the cost calculation using these new and updated forecasts.

In the final rule, the impact of future fuel price differentials is determined by selecting a "best practicable estimate" from the variety of forecasts available, and then allowing an applicant (or petitioner) to use an equivalent fixed annuity in the cost calculation. The fixed annuity is the levelized cost differential which is equivalent to the net present value of the difference between future oil and coal prices, discounted over the useful life of a new industrial installation. The ERA adopted the EIA medium scenario from the EIA Annual Report to Congress, 1979 as the best practicable estimate, and thereby adopted a fixed equivalent annuity of \$4.00 per barrel (in 1979 dollars).

In this study Decision Analysis Corporation (DAC) applied this same methodology to more current forecasts from EIA, DRI and WEFA. DAC also researched approximately 30 other private and public forecast sources seeking alternate oil and coal trajectories. This search resulted in the identification of three additional forecasts containing both coal and oil long term trajectories:

- o The American Gas Association's TERA Base Case Analysis (Nov., 1980)
- o The Electric Power Research Institute's Technical Assessment Guide (July, 1979)
- o The Chase Manhattan Bank's internal forecast for 1980, entitled Crude Oil and Coal Rules, 1980-1990 (1980).

The search also showed conclusively that free and available, published, long term forecasts containing both coal and oil price trajectories are indeed scarce. Several sources employ price trajectories in their forecasting techniques, but refrain from publishing them with supply and demand quantity projections because of the greater uncertainties inherent in the price forecasts. For some major oil companies, avoidance of fixing or price leadership allegations was the stated reason. Other price forecasts were available only as custom products for substantial fees. Consequently their limited availability to the general public rendered them unacceptable as a basis for regulation.

The updated imported oil and coal price trajectories from EIA, DRI and WEFA are graphically portrayed in Figure 0-1. (For notes and sources, see p. xi.)

FIGURE 0.1
Updated Oil and Coal Price Projections
From EIA, DRI and WEFA

A comparison of these updated trajectories with those in the NOPR leads to the following conclusions:

- o EIA's updated imported oil price trajectories are significantly

higher in all scenarios. For example, in the medium price forecast, the price of imported oil is 23% higher in 1995 and 100% higher in 2020.

- EIA's coal price trajectories are somewhat higher and do not vary significantly by scenario. EIA's updated medium price for industrial coal is 14% higher in 1995 and 22% higher in 2020 than the previous forecast.
- DRI's imported crude oil trajectory is moderately higher (16% in 2000) than its previous forecast, while its coal trajectory is lower (13% in 2000).
- WEFA's updated crude oil trajectory is slightly higher (1% in 1990) than the previous forecast, while its coal price trajectory is moderately lower (8% in 1990)

These updated trajectories result in revised equivalent fixed annuities, as depicted in Figure 0-2. In comparing these revised annuities to those shown in the NOPR (adjusted to 1980 dollars):

FIGURE 0.2
Comparison of Ranges of Equivalent Industrial Annuities --
Updated Projections From EIA, DRI, Wharton

ALT 1 Dashed line corresponds to lower of two initial 1980 residual fuel oil prices. (\$25.64/BBL)

ALT 2 Solid line corresponds to higher of two initial 1980 residual fuel oil prices. (\$29.77/BBL)

NOTE: For aids in interpreting this figure, see page xi.

- EIA's medium price scenario results in a fixed annuity ranging between \$6.56 and \$8.49 per barrel, (averaging about \$7.50 per barrel) as compared to the previous annuity range of \$3.58 to \$4.54 per barrel (averaging \$4.06 per barrel) in constant 1980 dollars.
- EIA's range of annuities across all three scenarios has increased, which indicates more uncertainty in relative price trajectories. All three scenarios result in fixed annuities higher than those for the previous forecasts, which indicates higher revised oil trajectories relative to coal.
- DRI's updated annuities are slightly higher than those associated with the previous forecast, and all of the annuities associated with DRI are higher than the corresponding ones of the EIA medium scenario.
- WEFA's revised annuities are lower than those of the previous forecasting which reflects the lower coal price trajectory now envisioned. These revised annuities compare more closely than DRI's to those of the EIA medium price scenario.

The oil and coal prices associated with the Electric Power Research Institute (EPRI), the American Gas Association (AGA) and the Chase Manhattan Bank (CMB) are shown in Figure 0-3 (for industrial prices) and Figure 0-4 (for utility prices). EPRI studies only the utility market and therefore its forecast could not be applied appropriately to the industrial market. The following conclusions result from comparing these alternative forecasts to those shown in Figure 0-1:

- The AGA is the most bullish of all on future coal prices. The 241% increase in real delivered industrial coal prices forecast over 1980-2000 contrasts greatly to the 65% increase for the EIA medium price scenario.
- The AGA's crude oil price trajectory (stated as assumed growth of 3% per year over 1980-2000) compares well with the 3.3% growth associated with the EIA medium scenario. However, due to the low initial 1980 price of residual fuel oil employed by AGA, its delivered industrial residual fuel oil price (shown in Figure 0-3) grows at an annual average of 5.8%, significantly higher than the growth rate for crude prices.
- CMB coal prices are the lowest of all forecasts presented and grow only at about the rate of inflation from 1980 to 1990 (virtually constant real prices).

FIGURE 0.3
Alternative Industrial Coal and Oil Price Projections

FIGURE 0.4
Alternative Utility Coal and Oil Price Projections

NOTE: For sources for Figures 0.3 and 0.4, see page xii.

- EPRI's prices for residual fuel oil delivered to utilities show only a 1.8% annual growth averaged over 1980-2020. This falls between corresponding growth rates of EIA's low and medium price scenarios for the same period.
- EPRI's price for coal delivered to utilities grows at 1.2% annually over the 1980-2020 which compares closely with the 0.9% rate for delivered utility coal prices corresponding to EIA's updated medium price scenario.

The equivalent fixed annuities corresponding to the AGA, EPRI and CMB forecasts are shown in Figures 0-5 and 0-6. The range of fixed annuity values

Fig. 0.5

NOTE: For explanatory notes, see page xii.

is widened substantially by the introduction of these three forecasts.

The following observations can also be made:

- When the residual fuel oil price trajectory provided by AGA is utilized in the annuity calculation, the resulting annuities fall between those for the EIA medium and high price scenarios.
- The CMB forecast provides the highest equivalent annuities of those presented in this report mainly because it provides the lowest coal price growth rates.
- The equivalent annuities associated with the utility sector corresponding to the EPRI and AGA forecast are only conservatively approximated by those associated with EIA's medium price scenario for the industrial sector.

FIGURE 0.6
Comparison of Ranges of Equivalent Annuities
From Alternate Sources -- Utilities

* Low, mid, and high range values correspond to high, mid, and low sulfur residual price trajectories. No extrapolation of original series required.

** Range values result from application to three extrapolation methods applied to original price series forecast to 2000.

The most striking conclusion observed when viewing Figure 0-5 is the significant difference an assumption can make when applying the fixed annuity calculation. When the AGA world crude oil growth assumption of 3% per year over 1980-2000 was applied to the 1980 residual oil price estimate to

obtain a price trajectory (which is the methodology used in the NOPR), all the fixed annuities were negative due to the high growth in coal prices forecast by AGA. When AGA's own trajectory of residual fuel oil prices was used, the resulting fixed annuities compared reasonably to those of EIA, DRI and WEFA. For EPRI, no crude oil price trajectory was provided; therefore, the actual published residual fuel oil price trajectories were used in the annuity calculation.

DAC investigated variations of equivalent fixed annuities given the regional projections provided by EIA. The results, displayed in Figure 0-7 for the EIA medium price scenario, show considerable variation of annuities

FIGURE 0.7
Comparison of Regional Industrial Equivalent Annuities
EIA Mid Range Scenario

* The National Average Regional Equivalent Annuity is not synonymous with the EIA Annuities presented in Figure 0.2 as is discussed in Section III.

among regions. The range of regional equivalent annuities, from \$14.27 to \$27.55 per barrel represents a difference of \$13.28 per barrel, or 70% of the national average. All three EIA scenarios were used in studying regional variations, and all showed correspondingly wide ranges on the resulting fixed annuities. EIA's region-specific residual fuel price trajectories were employed in the calculation of annuities instead of national crude oil growth rates to illustrate appropriately EIA's envisioned differences in delivered fuel prices among regions. No other forecast sources provided regional projections of both coal and oil prices, so none could be compared with EIA's.

NOTES

Figure 0-1 Sources:

- Energy Information Administration's Service Report (SR/IA/80-16) entitled "Preliminary 1985, 1990 and 1995 Energy Forecasts for the Annual Report to Congress, 1980," November, 1980.
- Data Resources Incorporated Energy Model Scenario Solution File (@ ENG/E1180), November, 1980.
- "Wharton Annual Model Pre-Meeting Solutions," October 1980.

Figure 0-2 Explanatory Notes:

The following are aids in understanding the basis for this figure:

1. The two-point ranges for each EIA scenario are derived from the use of two initial 1980 residual fuel oil prices (\$25.64 per barrel and \$29.77 per barrel) as computed in Section II.0 of this reports, Table II.0.2. No extrapolation method was necessary to compute EIA fixed annuities since the forecasts extended to the year 2020.
2. For both the DRI and WEFA scenarios, the fixed annuities associated with Alternative 1 correspond to use of the lower residual fuel oil price for 1980 (\$25.64 per barrel) and should be compared to the lower points of the three ranges associated with the EIA scenarios. The fixed annuities associated with Alternative 2 correspond to use of the higher initial residual fuel oil price (\$29.77 per barrel) and should be compared to the higher points of the ranges associated with the EIA scenarios.
3. For both the DRI and WEFA scenarios, extrapolation methods were necessary to extend the forecast horizons to the year 2020 in order to obtain trajectories over the 40 year useful life of a new industrial installation. Three were employed leading to the three points shown on the figure for Alternative 1 and Alternative 2. The three extrapolation methods are:
 - Method 1. Extend oil and coal price forecasts through 2020 using the growth rate computed over the last forecast period available, that is, the growth rate forecast for last five years of the published forecast period.

NOTES (cont'd.)

- Method 2. Oil and coal prices are assumed constant (after adjustment for inflation) at the last forecast year value through 2020.
 - Method 3. The oil price is assumed constant (net of inflation) at the last forecast year value; the coal price is assumed to grow at the rate forecast for the last five years of the published forecast period through the year 2020.
4. In general, extrapolation method 1 yields the highest fixed annuity and method 3 the lowest.
5. The format for this chart and the extrapolation methods employed are identical to those of the NOPR.

Figure 0-3 Sources:

- The American Gas Association's "TERA Base Case Scenario," November 21, 1980.
- Crude Oil and Coal Prices, 1980-1990, Chase Manhattan Bank, 1980.

Figure 0-4 Sources:

- The American Gas Association's "TERA Base Case Scenario," November 21, 1980.
- Technical Assessment Guide, Electric Power Research Institute, PS-1201-SR, July 1979.

Figure 0-5 Explanatory Notes:

- ¹ The range results for the application of three forecast extrapolation methods applied to AGA's actual forecast of industrial residual and coal prices, using the AGA initial 1980 residual price of \$21.12/BBL (1980 \$s).

The three exploration methods are:

- Method 1. Extend oil and coal prices through 2020, using the growth rate computed over the last five years by the forecast period.

NOTES (cont'd.)

- Method 2. Oil and Coal prices are assumed constant (net of inflation) at the last forecast year value.
- Method 3. The oil price is assumed constant (net of inflation) at the last forecast year value; the coal price is assumed to grow at the rate forecast for the last five years of the published forecast period through the year 2020.

² The ranges result from the application of the same three extrapolation methods to fuel oil price series initialized at three alternative 1980 residual fuel prices, and then escalated at AGA's assumed growth rate for world crude oil, 3% per year through 2000. Initial prices and corresponding line codes are:

—.—.— \$21.12/BBL, original AGA forecast;

----- \$25.64/BBL, lower of two alternative prices computed in section II.0 of this report;

———— \$29.77/BBL, higher of two alternative prices computed in section II.0 of this report.

³ The ranges result from the CMB forecast crude oil growth rate applied to the two alternative 1980 residual prices computed in section II.0 and extrapolated from 1990 to 2020 using the three methods. Dashed line corresponds to the initial residual price of \$25.64/BBL, and the solid line to \$29.77/BBL. The lower value of each range corresponds to the same annuity value resulting from series extrapolation methods 2 and 3.

I. Introduction

Background

The Economic Regulatory Administration (ERA) of the U.S. Department of Energy is responsible for the development of rules to implement Sections 211 (a) (1), 212 (a) (1) (A), 311 (a) (1), and 312 (a) (1) (A) of the Powerplant and Industrial Fuel Use Act of 1978. These sections provide for exempting certain facilities from conversion to an alternate fuel, as from oil or gas to coal, if it can be demonstrated that such conversion entails a cost that "substantially exceeds" that of using oil. Proposed rules governing the cost calculation procedure were published in 43 FR 53974, 54005, 54030 on November 17, 1978, and in 44 FR 5808, 5820, 5840 on January 29, 1979. Interim rules were published and adopted in 44 FR 28950, 28979, 28999 on May 17, 1979 and in 44 FR 43176, 43191, 43209 on July 23, 1979. In view of subsequent responses, the ERA decided to suspend the adoption of final rules and published new proposed rules, known as the Notice of Proposed Rulemaking (NOPR) in 45 FR 42190-42212 on June 23, 1980. Final rules were published in 45 FR 84967-80 of December 24, 1980.

The new proposed rules were accompanied in the preamble by forecasts of oil and coal price trajectories developed by three principal sources: The Energy Information Administration (EIA); Wharton Econometric Forecasting Associates, Incorporated (WEFA); and Data Resources, Incorporated (DRI). These oil and coal price forecasts were used as an initial information base

to calculate the present value of the net difference between projected oil and coal prices from 1980 through the year 2020, which corresponds to an assumed forty (40) year useful life for new industrial boilers. The net present value, or annuity equivalent, was calculated for oil/coal price pairs from each of the three sources cited above, using alternative assumptions about the 1980 price of #6 residual fuel oil and steam coal delivered to industry to initialize the price projections. Three alternative extrapolation methods to 2020 were applied to the WEFA and DRI forecasts, which ended in years 1990 and 2000, respectively. In all, eighteen (18) annuity equivalent values, corresponding to alternative initial price assumptions and forecast extrapolation methods, were tabulated and published in the NOPR.

I.1 Purpose and Contents of This Report

The net present value method of comparing costs associated with oil and alternate fuels depends on access to and use of projected values for oil and coal prices over a forty year period. In the NOPR, three sources of published projections were identified and used as an initial information base for the net present value calculations. In the interim, EIA, WEFA, and DRI have developed updated forecasts, which account for recent events in world energy markets and their effects on world and domestic energy prices, and revised expectations about domestic and international economic performance over the mid- and long-terms. Additionally, alternative published sources of long-run oil and coal price forecasts have been identified. This report presents findings resulting from a study conducted for the Office of Regulatory Policy, ERA, DOE, to:

- Acquire, analyze and report alternative published price projections including both oil and coal price trajectories, and
- Apply the fixed annuity formula to the updated primary source projections (EIA, DRI, WEFA) and to the newly acquired price projections.

This report also encompasses:

- Comparisons of key assumptions underlying the price projections, and
- A discussion of the applicability of the fixed annuity formula as used in the alternative cost calculation specified in the NOPR.

Section II of this report contains graphic presentations of all updated and newly acquired coal and oil price forecasts and the corresponding calculated annuity equivalents, tabulated presentations and discussions of each forecast and underlying assumptions, and a description

of how each forecast price series was transformed into input for the present-value formulas. Section III presents the fixed annuity formula employed and discusses its appropriateness for this application. Appendix A contains a listing of over 20 specific organizations and individuals that were contacted as potential sources of price forecasts with a summary of the outcome of the contact.

Appendix B contains the raw forecast data from each forecast source and the coal and oil price series derived from the raw data which were actually input into the cost calculation procedure. Appendix C contains a description and listing of the computer program developed to implement the cost calculation procedure. Finally, Appendix D contains tabulations and discussions of other alternative world crude price forecasts that were identified, but for which no corresponding coal price projections were available.

II. Updated Primary and Alternative Fuel Price Forecasts

Parts II.1 - II.3 of this section present the updated fuel price forecasts and correspondingly calculated annuity equivalent values for EIA (High, Mid, and Low scenarios), DRI, and WEFA, respectively. Parts II.4-II.6 contain forecasts and associated annuity equivalents for three alternate sources of fuel price forecasts identified for this study.

- The Electric Power Research Institute (EPRI)
- The American Gas Association (AGA), and
- The Chase Manhattan Bank (CMB).

Each of the six groups of forecasts presented is accompanied by summary descriptions of key indicators and assumptions underlying the specific forecast. Due to considerable variation in the purpose for which each forecast source prepared its fuel price projections, the scope of considerations entering the forecast, and the principal intended audiences, there is no common, consistent set of underlying assumptions or key variable trends on which all the forecasts are based. There is, however, a concept of the general level of economic activity associated directly or indirectly with each set of forecasts, such as real U.S. Gross National Product (GNP) or Gross Domestic Product (GDP) growth over the forecast horizon. The summaries of underlying indicators accompanying each forecast, therefore, emphasize the associated growth rate in economic activity.

Prior to presenting these results, baseline information is presented. This baseline information includes derived initial fuel price values, conversion factors, and GNP deflator values to prepare the

actual price series entering the annuity calculations.

II.0 Baseline Information

The first category of data to update, based on more recent information than available when the NOPR was published, is the average 1980 prices of imported crude oil and residual fuel oil. The average of "Refiner Acquisition Cost of Imported Crude," reported for June and July, 1980 in the November issues of the Monthly Energy Review (MER), was taken as the 1980 imported crude oil price. Data for the 1980 "PICO-PCCO" adjustment factor* and the average retail residual fuel oil prices were extracted from the same MER. Table II.0.1 contains the actual data used, the resulting crude price, and "PICO-PCCO" adjustment factor.

Table II.0.1
Initial 1980 Prices for Crude Oil
(\$/BBL)

	June 1980	July 1980	Average
Refiner Acquisition Cost of Imported Crude (PICO)	34.48	34.51	34.50*
Refiner Acquisition Cost of Crude, Composite (PCCO)	28.80	28.73	28.77
PICO-PCCO			5.73

Source: Monthly Energy Review, Nov., 1980; p. 72.

*Initial 1980 World Oil Price used to derive 1980-1985 growth rates for EIA projections.

- * This factor is the difference between the price of imported crude (PICO), and the composite price of crude to domestic refiners (PCCO). When added to the observed average retail price of #6 residual fuel oil (the domestic transaction price), it yields a higher figure which is interpreted in the NOPR as the replacement price of residual fuel oil at world oil market values. Domestic oil price decontrol, planned to take effect in 1981, will result in equilibrium between transaction price and replacement prices for residual fuel oil using this technique. Fixed annuities were calculated for fuel oil price trajectories initiated at both current transaction and replacement price levels, as performed in the NOPR.

Tables II.0.2 and II.0.3 contain the data used to calculate two alternative residual fuel oil prices for 1980, and the delivered industrial coal prices for 1980, respectively. The \$10.65/ton (\$.47/MMBTU) in 1979 dollars used in the NOPR to convert "delivered coal price to utility" to "delivered coal price to industry" (as referenced in 45 FR 42168, footnote 3), has been retained, and has been converted to mid-1980 dollars by multiplying by 1.094, which is the ratio of the DRI GNP deflator to the 1979 GNP deflator.

Table II.0.2
Initial 1980 Prices for #6 Fuel Oil
(\$/BBL)

	<u>June, 1980</u>	<u>July, 1980</u>	<u>Average</u>
Retail Price for #6 Residual Fuel Oil .31 to 1.0% sulfur	25.44	25.83	25.64*
Average Retail Price #6 Residual Fuel Oil all sulfur grades	24.09	23.98	24.04
(PICO-PCCO) Adjustment			5.73**
TOTAL Replacement Price			29.77*

Source: Monthly Energy Review, Nov., 1980; p. 83
Retail Resid Prices.

*Prices used as alternate industrial #6 residual fuel oil initial prices for 1980 to which projected crude growth rates from EIA, DRI, and WEFA forecasts are applied to derive alternate residual price projections.

**From Table II.0.1

NOTE: In the tables of this report, price series or single entries appearing under 'ALT 1' are associated with the lower of the two initial residual prices (\$25.64), and 'ALT 2' with the higher (\$29.77).

Table II.0.3
Initial 1980 Prices for Industrial Coal
(\$/MMBTU)

	<u>June, 1980</u>	<u>July, 1980</u>	<u>Average</u>
Cost of Coal Delivered to Steam-Electric Utility Plants	1.35	1.37	1.36
Adjustment to Reflect Delivered Price to Industrial Users			<u>.51*</u>
TOTAL			1.87**

Source: Monthly Energy Review, Nov., 1980, pg. 85.

*Cost adjustment per MMBTU for delivery to industrial customers assuming per ton adjustment of \$10.65 as cited in 45 FR 42198, June 23, 1980, footnote 3, adjusted to 1980 dollars by 1.094.

**Used as 1980 price of coal delivered to industrial users for computation of 1980-1985 growth rates in EIA coal price projections.

Table II.0.4 gives historical and projected values of the implicit GNP deflator. The 1980 predicted value of the deflator from DRI was taken as the factor with which to normalize all price forecasts to 1980 dollar equivalents, by virtue of its being the most recent (November, 1980) estimate available.* The base year of 1980 was selected for constant dollar normalization of all price forecasts due to availability of mid-1980 observed values for crude oil, residual fuel oil, utility steam coal, and the "PICO-PCCO" adjustment factor. The exact factor used to convert individual forecasts to 1980 dollars, based on DRI GNP deflator values in

* EIA has adopted this same convention in its Service Report (SR/IA/80-16), Preliminary 1985, 1990, and 1995 Energy Forecasts for the Annual Report to Congress, 1980, Pre-Publication Draft, Nov., 1980, pg. B-8.

Table II.0.4, is cited in each of the subsequent tables of forecast prices. For example, 1.094 was used to convert mid-1979 dollars to mid-1980 dollars, which is the ratio of the DRI 1980 GNP deflator to the 1979 GNP deflator.

Table II.0.4

Implicit GNP Deflator*

<u>Year</u>	<u>GNP Deflator, 1972 = 100</u>	<u>Year</u>	<u>Projected DRI</u>	<u>WEFA</u>
1970	91.36	1980	181.1	180.6
1971	96.02	1985	272.3	265.1
1972	100.00	1990	396.5	382.8
1973	105.80	2000	728.7	NA
1974	116.02			
1975	127.15			
1976	133.71			
1977	141.70			
1978	152.05			
1979	165.50			

*Sources: 1970-1979, Economic Report of the President, 1979, Table B-3; 1980-2000, WEFA--Wharton Annual Model Pre-Meeting Solutions, October, 1980, Table 23.1; DRI--Extracted from solution data base, scenario @ ENG/E1180, series 'PGNP' (the DRI mnemonic for the GNP deflator forecast).

Table II.0.5 compares initial fuel price values that appeared in the NOPR for use in the annuity calculations, with updated values used in this report. The most striking aspect of this comparison is the significantly lower updated residual fuel oil prices compared to those used in the NOPR. This occurs due to the actual slump in residual fuel oil prices observed in mid-1980.

Table II.0.5

Comparison of Residual Fuel Oil Prices, (\$/BBL)

	<u>Previous</u> (Industrial Only)		<u>Updated</u> Industrial		Utility
	ALT1	ALT2	ALT1	ALT2	
Nominal*	28.34	32.20	25.64	29.77	24.68
Mid-1979 \$'s	27.02	30.20	23.44	27.21	22.56
Mid-1980 \$'s	29.56	33.58	25.64	29.77	24.68

*Nominal: For Previous prices, January 1980 actual data were used; for Updated, mid-1980 price data were used.

Sources: Previous--ALT1, ALT2: 45 FR 42199, June 23, 1980, footnote 4.

Update--ALT1, ALT2: Retail Residual, .31 - 1.0% sulfur, and Average Retail (plus PICO-PCCO), respectively, MER, Nov., 1980, pg. 83.

Comparison of Initial Coal Prices (\$/MMBTU)

	<u>Previous</u> (Industrial Only)	<u>Updated</u> Industrial	Utility
Nominal**	1.79	1.87	1.36
Mid-1979 \$'s	1.70	1.70	1.24
Mid-1980 \$'s	1.87	1.87	1.36

*Nominal: The December 1979 actual price for the Previous estimate; the mid-1980 price for the Updated estimate.

Sources: Previous--45 FR 42198, June 23, 1980, footnote 3.

Update--Utility: MER, Nov., 1980, pg. 85, average of June-July, 1980 delivered prices.

Industrial--Utility plus \$.51/MMBTU.

Finally, Table II.0.6 lists the conversion factors used to standardize the unit of measure of fuel price series entering the fixed annuity calculation.

Table II.0.6

Conversion Factors and Constants

Million BTU per ton of steam coal:	22.5
Million BTU per barrel of crude oil:	5.8
Million BTU per barrel of residual oil:	6.287

Sources: Crude and residual values,
Monthly Energy Review, Nov., 1980.
Steam coal value, 'Preliminary 1985, 1990,
and 1995 Energy Forecasts for the Annual Report
to Congress, 1980,' Service Report SR/IA/80-16,
November, 1980.

II.1 Previous and Updated EIA Projections

THE FORECAST

Tables II.1.1 - II.1.3 provide both the previous coal and oil price forecasts used in the NOPR (and in EIA's Annual Report to Congress, 1979

Table II.1.1

EIA High-Range Price Forecast Update
(In 1980 dollars)*

Year	<u>Previous Forecast</u>		<u>Updated Forecast</u>	
	Imported Crude Oil (\$/BBL)	Industrial Coal (\$/MMBTU)	Imported Crude Oil (\$/BBL)	Industrial Coal (\$/MMBTU)
1980	-	-	34.50**	1.87**
1985	42.20	2.30	47.04	2.57
1990	48.21	2.49	53.61	2.91
1995	60.86	2.57	76.58	3.05
2000	65.64	2.67	101.71	3.05
2010	65.64	2.83	122.53	3.22
2020	65.64	3.26	146.57	3.60

Average Annual Rates of Price Change (Percent)

Period	<u>Previous Forecast</u>		<u>Updated Forecast</u>	
	Imported Crude Oil	Industrial Coal	Imported Crude Oil	Industrial Coal
1980-85	5.1	3.9	6.4	6.6
1985-90	2.7	1.7	2.6	2.5
1990-95	4.8	.6	7.4	.9
1995-2000	1.5	.8	5.8	0
2000-10	0	.6	1.9	.5
2010-20	0	1.4	1.8	1.0

Source: 45 FR 42192, June 23, 1980.

Source: ARC High-Range Scenario,
November, 1980.***

*Figures expressed in 1979 dollars were multiplied by 1.094 to convert to 1980 dollars.

**Figures derived in Table II.0.1 and Table II.0.3.

***Values for 1985, 1990, 1995 are taken from the EIA Service Report, SR/IA/80-16; values for 2000 to 2020 are taken from the LEAP Model run; version 1980.1.0, dated November 25, 1980.

(ARC-79)) and the updated forecasts which appear in the Service Report (SR/IA/80-16) and will appear in the ARC-80 when it is published in March, 1981. The effects of the world events which have occurred since publication of the ARC-79 price projections, have resulted in substantial

Table II.1.2

EIA Mid-Range Price Forecast Update
(In 1980 dollars)*

Year	<u>Previous Forecast</u>		<u>Updated Forecast</u>	
	Imported Crude Oil (\$/BBL)	Industrial Coal (\$/MMBTU)	Imported Crude Oil (\$/BBL)	Industrial Coal (\$/MMBTU)
1980	-	-	34.50**	1.87**
1985	35.08	2.30	40.48	2.54
1990	39.97	2.47	44.85	2.88
1995	44.39	2.58	54.70	2.98
2000	47.04	2.66	65.56	3.09
2010	47.04	2.82	78.68	3.27
2020	47.04	3.22	93.97	3.70

Average Annual Rates of Price Change (Percent)

Period	<u>Previous Forecast</u>		<u>Updated Forecast</u>	
	Imported Crude Oil	Industrial Coal	Imported Crude Oil	Industrial Coal
1980-85	1.6	3.9	3.2	6.3
1985-90	2.6	1.5	2.1	2.5
1990-95	2.1	.9	4.1	.7
1995-2000	1.2	.6	3.7	.7
2000-10	0	.6	1.8	.6
2010-20	0	1.3	1.8	1.2

Source: 45 FR 42192, June 23, 1980.

Source: ARC Mid-Range Scenario, Nov., 1980.***

*Figures expressed in 1979 dollars were multiplied by 1.094 to convert.

**Figures derived in Table II.0.1 and Table II.0.3. to 1980 dollars.

***Values for 1985, 1990, 1995 are taken from the EIA Service Report, SR/IA/80-16; values for 2000 to 2020 are taken from the LEAP Model run; version 1980.1.0, dated November 25, 1980.

upward revisions of oil price trajectories in all three scenarios (high, mid, low) over prior projections. Coal prices have been revised upward as well, although only moderately relative to oil. Figure II.1.1 illustrates the previous and updated EIA projections.

Table II.1.3

EIA Low-Range Price Forecast Update
(Figures expressed in 1980 dollars)*

Year	<u>Previous Forecast</u>		<u>Updated Forecast</u>	
	<u>Imported Crude Oil (\$/BBL)</u>	<u>Industrial Coal (\$/MMBTU)</u>	<u>Imported Crude Oil (\$/BBL)</u>	<u>Industrial Coal (\$/MMBTU)</u>
1980	-	-	34.50**	1.87**
1985	29.54	2.29	34.88	2.49
1990	29.54	2.45	34.88	2.79
1995	29.54	2.55	34.88	2.90
2000	29.54	2.63	45.94	3.07
2010	29.54	2.77	53.62	3.27
2020	29.54	3.05	63.45	3.72

Average Annual Rates of Price Change (Percent)

Period	<u>Previous Forecast</u>		<u>Updated Forecast</u>	
	<u>Imported Crude Oil</u>	<u>Industrial Coal</u>	<u>Imported Crude Oil</u>	<u>Industrial Coal</u>
1980-85	-1.5	3.8	.2	5.9
1985-90	0	1.4	0	2.3
1990-95	0	.8	0	.8
1995-2000	0	.6	5.7	1.1
2000-10	0	.5	1.6	.6
2010-20	0	1.0	1.7	1.3

Source: 45 FR 42192, June 23, 1980.

Source: ARC Mid-Range Scenario,
Nov., 1980.***

*Figures expressed in 1979 dollars were multiplied by 1.094 to convert to 1980 dollars.

**Figures derived in Table II.0.1 and Table II.0.3.

***Values for 1985, 1990, 1995 are taken from the EIA Service Report, SR/IA/80-16; values for 2000 to 2020 are taken from the LEAP Model run; version 1980.1.0, dated November 25, 1980.

Notes to Tables II.1.1 - II.1.3
Initial Growth Period Growth Rate Computations

The initial period price growth rate, 1980-1985, appearing in Tables I.1.1-I.1.3 were computed as follows:

PREVIOUS FORECAST

The initial imported crude price was the January, 1980 reported refiner acquisition cost for imported crude, \$30.75, deflated by 1.049 to normalize to mid-1979 constant dollars yielding \$29.31/BBL. Computed 1980-1985 growth rates are based on a 5.5 year timespan between the January, 1980 crude price, and the forecast price for mid-1985, with both figures expressed in mid-1979 dollar terms.

The initial industrial coal price was the December, 1979 price of coal delivered to steam-electric plants, \$1.29/MMBTU, deflated by 1.049 to mid-1979 dollars, and adjusted upward by \$.47/MMBTU. As with oil, the growth rate is based on a 5.5 year period.

(See NOPR, 45 FR 42198-42199, footnote 3)

UPDATED FORECAST

The initial 1980 crude oil price used is \$34.50/BBL (from Table II.0.1), the mid-1980 price expressed in mid-1980 dollars. The applicable timespan for the growth rate computation is five years.

The 1980 price for delivered industrial coal, \$1.87/MMBTU is derived in Table II.0.3. The timespan that applies is again five years.

FIGURE II.1.1
Previous and Updated EIA Projections.

ANNUITY EQUIVALENT CALCULATION

For the alternate fuel cost calculation procedure, two series of residual fuel oil price trajectories were developed for each EIA price scenario. Using the two 1980 residual prices shown in Table II.0.2 as initial values, two series through 2020 were developed by applying the average annual growth rate corresponding to projected world crude oil prices to each initial residual fuel oil price, for each EIA price scenario. This is the same methodology used in the NOPR. Table II.1.4 shows the results of this cost calculation applied to the updated forecasts along with the corresponding values published in the NOPR. Note that all updated fixed annuities are higher due to higher world oil price

Table II.1.4

COMPARISON OF ANNUITIZED FUEL COST DIFFERENCE - EIA (1980 \$s/BBL Equivalent)

<u>EIA Scenario</u>	<u>Range</u>	<u>Previous Forecast</u>	<u>Updated Forecast</u>
High	Max	15.04	22.67
	Min	12.81	18.76
Mid	Max	4.54	8.49
	Min	3.58	6.56
Low	Max	-5.24	-1.42
	Min	-5.50	-1.93

trajectories utilized by EIA. Figure II.1.2 displays graphically the data in Table II.1.4. The actual price series used in the cost calculation procedure are shown in Tables B-2 through B-4 in Appendix B.

FIGURE II.1.2
EIA Projections
Previous and Update Ranges of Equivalent Annuity Values

INDICATORS AND ASSUMPTIONS UNDERLYING THE FORECAST

The principal variables which provide insight on conditions related to EIA's high, mid, and low price forecasts, and their changes between scenarios, are (1) assumed growth rates in the U.S. Gross National Product and the World Gross Domestic Product, (2) assumed levels of associated OPEC crude production capacity, and (3) projected free world energy consumption. Other assumptions are made by EIA in creating its world oil price trajectories, which are discussed in Chapter 2 of the ARC-80, Volume 3 B. The principal variables highlighted here indicate the strengths of world energy demand and supply forces, respectively. In reality, baseline EIA imported oil price trajectories are determined outside of the domestic forecasting models, thus constituting one of the key assumptions behind the domestic forecasts.

Table II.1.5, shows values for economic growth rates, OPEC crude oil production capacities, and total world consumption of energy associated with both the previous and updated price projections. Moderate declines in U.S., Organization for Economic Cooperation and Development (OECD), and total free world energy consumption are forecast in 1995, and no change in OPEC crude production capacities is assumed. In brief, EIA forecasts a continuing depressive effect of higher world oil prices on energy demand.

An important difference between the ARC-79 and ARC-80 forecasts is shown in the system price elasticities employed.* (A system elasticity is defined as a percentage change in the consumption of a product given a

* Since consumption generally declines with rising prices, the price elasticity is expressed as a number between zero and minus infinity. Demand (consumption) is said to be price-inelastic if the elasticity is between -1 and 0.

TABLE II.1.5

INDICATORS UNDERLYING THE EIA FORECAST
REAL AVERAGE ANNUAL ECONOMIC GROWTH RATES (%), 1977-1995¹
(GNP or GDP)

<u>Price Scenario</u>	<u>Region</u>		<u>Previous</u>	<u>Update</u>
High	U.S.	GNP	2.6	2.4
	OECD	GDP	3.0	2.3
	FREE WORLD	GDP	3.7	3.2

Mid	U.S.	GNP	2.6	2.4
	OECD	GDP	2.9	2.7
	FREE WORLD	GDP	3.6	3.4

Low	U.S.	GNP	2.8	2.7
	OECD	GDP	2.8	3.1
	FREE WORLD	GDP	3.5	3.7

¹Sources: Previous - Table 2.1, Annual Report to Congress, 1979
Update - Draft, Table 2.1, Annual Report to Congress, 1980

OPEC PRODUCTION CAPACITIES²
(MMBD, Range Between High Price - Low Supply,
and Low Price - High Supply Scenarios)

<u>Year</u>	<u>Previous</u>	<u>Update</u>
1985	30.5 - 38.0	30.5 - 38.0
1990	28.8 - 38.0	28.8 - 38.0
1995	28.0 - 37.6	28.0 - 37.6

²Sources: Previous - Table 2.7, ARC 1979, pg. 19.
Update - Draft Table 2.10, ARC 1980.

TABLE II.1.5 (cont'd.)

WORLD ENERGY CONSUMPTION³
 MID-RANGE PRICE SCENARIO
 (Quadrillion BTU)

<u>Year</u>	<u>Region</u>		
1985	U.S.	82.6	79.6
	OECD	169.2	170.0
	FREE WORLD	215.7	214.8
<hr/>			
1990	U.S.	89.8	87.9
	OECD	186.0	188.2
	FREE WORLD	246.1	246.8
<hr/>			
1995	U.S.	97.4	94.7
	OECD	207.3	205.9
	FREE WORLD	283.2	278.8

³Sources: Previous - Table 2.14, ARC - 1979, pg. 30.
 Update - Draft Table 2.17, ARC - 1980.

percentage change in the price of the product when substitution of fuels is allowed.) Table II.1.6 compares the system elasticities at the equilibrium points of the previous and updated forecast series. The substantial change in the estimated system price elasticity of demand for residual fuel oil (from -1.42 in the 1979 forecast to -.31 in the 1980 forecast) illustrates a substantial change in the representation of the ease of substitution to coal despite the growing cost differential between the two fuels (i.e., substitution is more difficult in the 1980 forecast scenarios than was the case in the 1979 forecasts).

TABLE II.1.6

ESTIMATED SYSTEM PRICE ELASTICITY FOR OIL - 1995¹
(Includes Fuel Substitution Effects)²

<u>Product</u>	<u>Region</u>	<u>Previous</u>	<u>Update</u>
All Oil	U.S.	- .44	-.23
	OECD	- .43	-.27

Residual	U.S.	-1.42	-.31
	OECD	- .32	-.29

¹Sources: Previous - Table 2.16, ARC, 1979, pg. 32.
Update - Draft Table 2.19, ARC, 1980.

²System price elasticity is defined as a percentage change in consumption given a percentage change in price for a product when substitution is allowed.

II.2. Previous and Updated DRI Projections

THE FORECAST

Table II.2.1 contains the previous and updated DRI projections of oil and coal prices through year 2000. Both forecasts are displayed graphically in Figure II.2.1. The updated oil price trajectory, while moderately higher than the previous forecast, falls between the updated EIA-mid and EIA-high price projections. The updated coal price trajectory is lower than the

TABLE II.2.1

DATA RESOURCES, INC. PRICE FORECAST UPDATE
(In 1980 Dollars)*

	PREVIOUS FORECAST		UPDATED FORECAST	
	Imported Crude Oil (\$/BBL)	New Contract Coal (\$/MMBTU)	Imported Crude Oil (\$/BBL)	New Contract Coal (\$/MMBTU)
<u>Year</u>				
1980	33.62	1.59	36.15	1.50
1985	39.06	2.02	42.55	1.87
1990	45.20	2.30	51.50	2.03
1995	52.56	2.52	62.38	2.23
2000	60.83	2.71	70.26	2.35

AVERAGE ANNUAL RATES OF CHANGE
(Percent)

<u>Period</u>				
1980-85	3.0	5.0	3.3	4.5
1985-90	3.0	2.5	3.9	1.7
1990-95	3.1	1.9	3.9	1.9
1995-2000	3.0	1.5	2.4	1.1

Source: 45 FR 42193, June 23, 1980

Source: Data Resources, Inc.
Energy Model Scenario Solution
File, '@ENG/E1180', Nov., 1980

*Figures in 1979 dollars were multiplied by 1.094 to convert to 1980 dollars.

previous DRI forecast and considerably lower than the updated EIA low industrial coal price projection. However, it should be noted that DRI's new contract coal price is not strictly comparable to EIA's price of delivered industrial coal. EIA's price contains more of the transportation costs incurred. In the NOPR, the DRI new contract price was utilized by ERA, hence it is used again in this report. In addition, there is no factor provided by DRI which could be used to convert new contract prices to delivered industrial coal prices.

FIGURE II.2.1
Previous and Updated DRI Projections

In terms of compound annual growth rates, the DRI updated oil price projection grows at 3.3% per year over the period 1980-2000, versus 2.5% in the previous forecast. The updated coal price trajectory grows at 2.3% per year versus 2.7% previously. Although the absolute price levels differ, the 1980-2000 growth rates exhibited by DRI's updated coal and oil price projections are very similar to those of EIA's updated mid-price

scenario. The corresponding growth rates for EIA over the 1980-2000 period are 3.3% and 2.5% per year for imported oil and coal, respectively. These growth rates are based on 1980 estimates derived in this report.

ANNUITY EQUIVALENT CALCULATION

Table II.2.2 shows the results of the annuity calculation for both the previous and updated DRI price forecasts. Figure II.2.2 displays the same information graphically. The updated annuities are higher as expected, given the higher trajectory for oil and the lower one for coal.

TABLE II.2.2

COMPARISON OF ANNUITIZED FUEL COST DIFFERENCES - DRI
(1980 \$/BBL EQUIVALENT)

	<u>Previous</u>		<u>Update</u>	
	<u>ALT1</u>	<u>ALT2</u>	<u>ALT1</u>	<u>ALT2</u>
Extrapolation Method 1*	9.38	11.42	10.52	12.77
Extrapolation Method 2	6.89	8.52	8.66	10.57
Extrapolation Method 3	6.42	8.01	8.42	10.32

* Extrapolation methods are explained in Appendix B.

FIGURE II.2.2
DRI Projections
Previous and Updated Ranges of Equivalent
Annuity Values

The alternative initial residual fuel oil prices used as base year values are shown in Table II.0.2 above. Application of the update forecast growth rate for imported crude prices to the initial year residual prices yields two alternative residual price trajectories through year 2000. To extend these series to 2020, three extrapolation methods are applied (as in 45 FR 42199, footnote 7, June 23, 1980). The three extrapolation methods are explained in Appendix B and are identical to those used in the NOPR. Tables B-6 through B-8 in Appendix B contain the oil and coal price series actually input to the cost calculation formula, based on the DRI updated forecast.

INDICATORS AND ASSUMPTIONS UNDERLYING THE FORECAST

Table II.2.3 summarizes key indicators underlying the previous and updated oil and coal price projections. Like EIA, DRI has lowered its estimate of real GNP growth from 1980-2000. The compound annual rate of real GNP growth from 1977-2000 of 2.5% per year for the updated projection is similar to that for the updated EIA high oil price scenario, 2.4% per year for the period 1977-1995.

TABLE II.2.3
INDICATORS UNDERLYING THE DRI FORECAST

Indicator	Previous ¹	Update ²
Real GNP Growth:		
1980-1990	3.2%/yr.	3.0%/yr.
1990-2000	2.3%/yr.	2.2%/yr.
1977-2000	NA	2.5%/yr.

Implicit GNP Deflator Growth:		
1980-1990	7.7%/yr.	8.2%/yr.
1990-2000	6.2%/yr.	6.3%/yr.
1980-2000	6.9%/yr.	7.8%/yr.

¹ DRI Energy Review, Winter 1980, Vol. 4, No. 1. Table A-1, page 138 and Table A-3, pg. 140.

² DRI update energy scenario solution file '@ENG/E1180', Nov., 1980. Variable names: 'PGNP' = GNP deflator, 'GNP72' = in 1972 dollars.

The associated DRI growth rate in the GNP deflator averages 7.8% per year over the period 1980-2000, which is nearly a full point higher than that of DRI's previous forecast over the same period. The GNP deflator was selected here as an indicator mainly because DRI produces

its forecast in nominal rather than real dollars, and few other assumptions or indicators were available because these DRI trajectories were obtained from the model solution data base, prior to the availability of the published forecast.

II.3 Previous and Updated Wharton Projections

THE FORECAST

Table II.3.1 contains the previous and updated WEFA projections of imported crude oil and coal prices through the year 1990. Both projections are displayed graphically in Figure II.3.1. The updated oil price projection

TABLE II.3.1

WEFA PRICE FORECAST UPDATE (In 1980 Dollars)*

	PREVIOUS FORECAST		UPDATED FORECAST	
	Imported Crude Oil (\$/BBL)	Domestically Produced Coal (\$/Short Ton)	Imported Crude Oil (\$/BBL)	Domestically Produced Coal (\$/Short Ton)
<u>Year</u>				
1980	32.04	30.09	32.25	27.47
1985	39.10	31.13	40.78	32.77
1990	42.83	31.83	43.45	29.27

AVERAGE ANNUAL RATES OF PRICE CHANGE (Percent)

<u>Period</u>				
1980-85	4.1	.7	4.8	.9
1985-90	1.8	.4	1.3	.3

Source: 45 FR 42193, June 23, 1980

Source: Wharton Annual Model Pre-Meeting Solutions, October, 1980, p.21

* Figures expressed in 1979 dollars were multiplied by 1.094 to convert to 1980 dollars.

FIGURE II.3.1
Previous and Updated WEFA Projections

is only marginally higher than the previous projection, while the new coal price forecast is substantially lower than previously. Both the updated oil and coal price trajectories from WEFA are considerably lower than EIA's corresponding updated low scenario price trajectories. Again, the WEFA price of domestically produced coal is not directly comparable to EIA's price of delivered industrial coal; it does not contain all the transportation costs included in EIA's delivered price. Also, the WEFA projection does not provide an estimate of the national average of these transportation costs.

The compound growth rates exhibited by the WEFA updated oil and coal price forecasts over their 1980-1990 projection horizon are 3% and 0.6% per year, respectively, which are nearly identical to the corresponding rates of the previous forecast. The 0.6% rate of coal price growth is lower, by a factor of 4, than those of EIA and DRI.

ANNUITY EQUIVALENT CALCULATION

Table II.3.2 shows the results of the annuity calculation for both the previous and updated WEFA price forecasts. Figure II.3.2 displays the same information graphically.

TABLE II.3.2

COMPARISON OF ANNUITIZED FUEL COST DIFFERENCES - WEFA
(1980 \$/BBL EQUIVALENT)

	<u>Previous</u>		<u>Update</u>	
	<u>ALT1</u>	<u>ALT2</u>	<u>ALT1</u>	<u>ALT2</u>
Extrapolation Method 1*	11.04	12.60	8.90	10.42
Extrapolation Method 2	7.36	8.40	6.70	7.84
Extrapolation Method 3	7.05	8.07	6.58	7.72

*Extrapolation methods are explained in Appendix B.

FIGURE II.3.2
WEFA Projections
Previous and Update Ranges of Equivalent
Annuity Values

The alternative initial residual fuel oil prices used as base year values are shown in Table II.0.2 above. Application of the updated forecast growth rates for imported crude prices to the initial year residual values yields two alternative residual price trajectories through year 1990. To extend these series to 2020, three extrapolation methods are applied (as in 45 FR 42199, footnote 7, June 23, 1980). The three extrapolation methods are explained in Appendix B. Tables B-10 through B-12 in Appendix B contain the oil and coal price series input to the cost calculation formula, based on the WEFA updated forecast.

The fixed annuities corresponding to the updated WEFA projection are lower than those corresponding to the previous projection. This results from the fact that the two alternative residual fuel oil prices used as base year values for the oil trajectory computation are significantly less than those adopted in the NOPR (See Table II.0.5). The updated coal price forecast, although lower than the previous forecast, is not sufficiently lower to offset the lower initial residual fuel oil prices used in the updated annuity calculation. The net result is a reduction in the values of the calculated annuities corresponding to the updated forecast relative to those appearing in the NOPR.

INDICATORS AND ASSUMPTIONS UNDERLYING THE FORECAST

Table II.3.3 summarizes key indicators underlying the previous and updated WEFA forecasts. Although the periods for which growth rates have been computed differ by one year (updated vs. previous forecast), the updated growth rate in real domestic GNP of 3.0% for the period 1980-1990 shows increased optimism over the previous forecast, and is similar to the growth rate underlying DRI's update forecast. WEFA's oil and coal price

trajectories, however, are considerably lower than DRI's through 1990.

WEFA's forecast of the GNP deflator of 7.8% averaged over the 1980-1990 period is similar to their previous estimate and compares closely to DRI's 8.2%.

TABLE II.3.3

INDICATORS UNDERLYING THE WEFA FORECAST

Indicator	Previous ¹	Update ²
Real GNP Growth:		
1980-1990	NA	3.0%
1979-1989	2.6%	NA
Implicit GNP Deflator Growth:		
1980-1990	NA	7.8%
1979-1990	7.8%	NA

¹Wharton Annual Model, Pre-Meeting Solutions, April, 1980. Table 1, 'Selected Indicators'. (This document is the source of the Wharton forecast appearing in the NOPR, 45 FR, June 23, 1980.)

²Wharton Annual Model, Pre-Meeting Solutions, Oct., 1980. Table 1, 'Selected Indicators'.

NA: Not available.

II.4 The Electric Power Research Institute Projections

THE FORECAST

Tables II.4.1 and II.4.2 contain the EPRI delivered prices to utilities for residual fuel oil and coal through the year 2020. These data are illustrated in Figure II.4.1. These forecasts are contained in the EPRI Technical Assessment Guide, July, 1979, which serves as a common source of data and cost calculation procedures to be used by EPRI staff and contractors in the economic analysis of alternative research and development programs. The EPRI does not provide a forecast of imported crude oil prices; therefore, the forecast of residual fuel oil prices was utilized. Having been formulated in mid-1979, the EPRI forecast of residual fuel oil prices does not take into account the more recent oil price increases.

For the period 1980-2020, the rate of compound growth for the average of EPRI's residual oil price projections is 1.8% per year. This is very close to EIA's updated low oil price scenario growth rate of 1.4% per year for imported crude oil over the same period. EPRI's average coal price delivered to utilities grows at 1.2% per year versus a 0.9% rate for EIA's updated mid-price scenario.*

* The EIA 0.9% growth rate applies to the average delivered price of coal to utilities for all grades and is calculated using the LEAP output tables for ARC-80.

TABLE II.4.1

ELECTRIC POWER RESEARCH INSTITUTE
RESIDUAL FUEL OIL PRICE PROJECTIONS
(In 1980 dollars, delivered price to utilities, \$/BBL)*

Year	Lo Sulfur	Mid Sulfur	Hi Sulfur	Average**
1980	31.08	28.49	25.52	28.36
1985	31.82	29.14	26.10	29.02
1990	35.21	32.25	28.85	32.10
1995	40.20	36.52	32.68	36.46
2000	46.57	42.65	38.17	42.46
2010	53.22	48.73	43.67	48.54
2020	62.54	57.26	51.25	57.02

AVERAGE ANNUAL RATES OF PRICE CHANGE
(Percent)

Period	Lo Sulfur	Mid Sulfur	Hi Sulfur	All Grades,** Average Price
1980-85	.5	.5	.4	.5
1985-90	2.1	2.0	2.0	2.0
1990-95	2.7	2.5	2.5	2.6
1995-2000	3.0	3.2	3.2	3.1
2000-10	1.3	1.3	1.4	1.3
2010-20	1.6	1.6	1.6	1.6

Source: Technical Assessment Guide, EPRI PS-1201-SR, July 1979, Exhibit 5-1.

* Numbers expressed in end-of-year 1978 dollars were multiplied by 1.148 to convert to mid-1980 dollars.

** Simple arithmetic averages; not volume-weighted, since volumes were not available.

TABLE II.4.2

ELECTRIC POWER RESEARCH INSTITUTE
DOMESTIC COAL PRICE PROJECTIONS
(In 1980 dollars; delivered price to utilities, \$/BBL)*

Year	Region								Average,** All Regions
	NE	MA	SE	EC	WC	SC	MTN	PAC	
1980	1.49	1.67	1.74	1.68	1.14	1.24	.72	1.48	1.40
1985	1.72	1.90	1.87	1.75	1.30	1.29	.93	1.48	1.53
1990	1.95	2.12	1.99	1.85	1.48	1.35	1.15	1.47	1.67
1995	1.96	2.19	2.05	1.92	1.55	1.49	1.30	1.63	1.76
2000	2.09	2.20	2.08	1.95	1.62	1.65	1.43	1.71	1.84
2010	2.33	2.34	2.24	2.12	1.85	1.85	1.67	1.85	2.04
2020	2.61	2.55	2.48	2.36	2.16	2.11	1.94	2.08	2.29

AVERAGE ANNUAL RATES OF PRICE CHANGE (Percent)

	Region								Based on ** Average of Regional Prices
	NE	MA	SE	EC	WC	SC	MTN	PAC	
1980-85	2.9	2.6	1.4	.9	2.6	.8	5.2	0	1.8
1985-90	2.5	2.6	1.3	1.1	1.6	1.0	4.3	-.1	1.8
1990-95	.1	.7	.5	.8	1.0	1.9	2.4	2.0	1.1
1995-2000	1.3	.1	.3	.3	.8	2.0	1.9	1.0	0.9
2000-10	1.1	.6	.8	.8	1.3	1.1	1.6	1.5	.9
2010-20	1.2	.9	1.0	1.1	1.6	1.3	1.5	1.2	1.2

Source: Technical Assessment Guide, EPRI PS-1201-SR, July 1979, Exhibit 6-1.

* Numbers expressed in end-of-year 1978 dollars were multiplied by 1.148 to convert to mid-1980 dollars.

** Simple arithmetic, averages; and not volume-weighted, since volumes were not available.

FIGURE II.4.1
EPRI Fuel Price Projections

ANNUITY EQUIVALENT CALCULATIONS

Table II.4.3 shows the results of the annuity calculation using EPRI data. Figure II.4.2 presents the same data graphically. Since EPRI's oil price projections are expected values of delivered residual fuel oil price to utilities, and imported crude oil price trajectories were not provided,

TABLE II.4.3

ANNUITIZED FUEL COST DIFFERENCE - EPRI

(1980 \$s/BBL equivalent, discounting at 2.9% from 1980 to 2015)

<u>SULFUR CONTENT</u>	<u>ANNUITY</u>
Lo	\$7.34
Mid	\$6.49
Hi	\$5.58

FIGURE II.4.2
EPRI Projections
Range of Equivalent Annuity
(Low, mid, high sulfur, discounted at 2.9%)

the original data were input directly to the annuity formula after normalization to 1980 dollars. Fuel oil price series were not derived by applying crude oil price growth rates to alternate base year residual prices.* The annuity was calculated for each of the three sulfur levels of residual oil detailed by EPRI relative to the average of their regional coal price projections. Although EPRI's coal price projections are at Census Division level, their fuel oil price projection is at the national level. Since no volumes are associated with either the coal or oil price forecasts, simple arithmetic averages were calculated instead of volume-weighted price averages.

* The (PICO-PCCO) adjustment factor was not added to EPRI's oil price projection for the annuity calculation. EPRI does not indicate what crude oil price assumption was made in generating their fuel oil price projections. Addition of the (PICO-PCCO) adjustment factor may introduce an unknown bias to the calculated EPRI annuity.

The utility discount factor used in the NOPR, 2.9%, was applied in view of EPRI's delivered price to utilities concept embodied in the projections. EPRI does not study the industrial market when making these projections, only the utility market. Therefore, it would have been inappropriate to apply EPRI's forecast to the industrial sector through some adjustment technique. The assumed physical lifetime of a non-nuclear powerplant, 35 years, was used in the cost calculation as required by the NOPR (45 FR 42197). Thus, EPRI's price series was used only through 2015. The actual series to the cost calculation formulas are shown in Table B-14 in Appendix B.

INDICATORS AND ASSUMPTIONS UNDERLYING THE FORECAST

The principal assumptions underlying EPRI's price projection are growth rates in electric utility loads (net generation) through 2000 and 2020. For comparisons, these assumptions are summarized in Table II.4.4, which includes load growth rates associated with EIA's mid-price scenario over periods similar to EPRI's.

TABLE II.4.4

INDICATORS UNDERLYING THE EPRI FORECAST

LOAD GROWTH (Net Generation)¹

1977-2000 4.7% per yr.

2000-2020 3.0% per yr.

COMPARE:

EIA UPDATED MID-PRICE PROJECTION

LOAD GROWTH (Net Generation)²

1975-2000 3.0% per yr.

2000-2020 1.9% per yr.

¹Source: EPRI, Technical Assessment Guide, July 1979.²Mid-Price Scenario LEAP Output Tables for ARC '80 pg. 8, line 92.

The EPRI load growth expectations are substantially higher than those corresponding to EIA's update forecast. For the period 1977-2000, the EPRI assumption, as of July, 1979, was 4.7% per year. In EIA's updated mid-price scenario, the rate for the period 1975-2000 is 3% per year.

II.5 The American Gas Association Projections

THE FORECAST

Tables II.5.1 and II.5.2 contain the AGA's projections of fuel oil and coal price trajectories through the year 2000, for both utility and industrial end-users. The forecasts are displayed graphically in Figure II.5.1. These forecasts are generated by their Total Energy Resource Analysis (TERA) model of domestic energy markets, developed primarily to

TABLE II.5.1

AMERICAN GAS ASSOCIATION OIL PRICE PROJECTIONS

YEAR	Weighted Average Delivered ¹ Fuel Oil Price to Utilities (1980 \$s/BBL)	Residual Fuel Oil Price to Industry (1980 \$s/BBL)
1980	23.90	21.12
1985	38.16	38.03
1990	46.79	47.18
1995	55.08	55.93
2000	64.64	65.90

AVERAGE ANNUAL RATES OF PRICE CHANGE (Percent)

PERIOD	Weighted Average Fuel Oil Price to Utilities	Residual Fuel Oil Price to Industry
1980-85	9.7	12.5
1985-90	4.2	4.4
1990-95	3.3	3.5
1995-2000	3.3	3.3

Source: AGA, TERA Base Case Scenario, November 21, 1980

¹The factor 6.06 was used to convert AGA's original forecast, expressed in \$/MMBTU, to \$/BBL. This factor is the average of 6.287 (BTU content of residual, millions) and 5.825 (BTU content of distillate, millions).

TABLE II.5.2

AMERICAN GAS ASSOCIATION COAL PRICE PROJECTIONS

YEAR	Coal Price Delivered to Utilities (1980 (\$/MMBTU))	Coal Price Delivered to Industry (1980 \$MM/BTU)
1980	1.32	1.63
1985	2.21	2.78
1990	2.28	2.90
1995	3.21	4.11
2000	4.35	5.56

AVERAGE ANNUAL RATES OF PRICE CHANGE (Percent)

PERIOD	Coal Price Delivered to Utilities	Coal Price Delivered to Industry
1980-85	11.0	11.3
1985-90	.6	.8
1990-95	7.1	7.2
1995-2000	6.3	6.2

Source: AGA, TERA Base Case Scenario, November 21, 1980

assist the gas utility industry in their system planning and policy evaluation activities.

The compound growth rates exhibited by the AGA's fuel oil and coal price projections over the period 1980-2000 are generally higher than those corresponding to EIA's updated high crude oil price scenario. Prices of residual fuel oil and coal delivered to industry grow at 5.9% and 6.3% per

year, respectively, versus EIA's 5.6% and 2.5% per year for imported crude oil and delivered coal respectively. Fuel oil prices to utilities, defined

FIGURE II.5.1
AGA Fuel Price Projections

by AGA as a volume weighted average of residual and distillate prices, grow at 5.1% annually over the 1980-2000 period, with utility coal at 6.1%.

Underlying AGA's fuel oil price forecasts is the stated assumption that real world crude oil prices will grow at a 3% per year rate through 2000. Table II.5.3 contains forecasts of industrial residual fuel oil prices based on the 3% growth rate assumption using the same methodology as in the NOPR. The three trajectories correspond to three alternative

initial year prices: AGA's forecast of the 1980 industrial residual price, and the two alternative prices derived in Table II.0.2.

TABLE II.5.3

American Gas Association Industrial Fuel Oil
Price Forecast Based on 3% Per Year
REAL WORLD CRUDE OIL PRICE GROWTH¹
(In 1980 dollars)

YEAR	Using AGA ² 1980 Industrial Residual Price	Using Lower Alternative ² Industrial Residual Residual Price	Using Higher Alternative ³ Industrial Residual Price
1980	21.12	25.64	29.77
1985	24.48	29.72	34.51
1990	28.38	34.46	40.01
1995	32.90	39.95	46.38
2000	38.15	46.31	53.77

¹ Table entries for other than 1980 base year values are based on 3% per annum real compound growth rate from 1980 through 2000.

² See Table II.5.1

³ See Table II.0.2

ANNUITY EQUIVALENT CALCULATIONS

Table II.5.4 shows the results of the annuity calculations for AGA's actual delivered price to utility and delivered price to industry forecasts. The same information is displayed graphically in Figure II.5.2.

TABLE II.5.4

ANNUITIZED FUEL COST DIFFERENCE - AGA
 (Using AGA Actual Forecast Values for Fuel Oil)
 (1980 \$s/BBL Equivalent)

Utilities
 (Discounted @ 2.9% Over 35 Years)

	<u>Annuity</u>
Extrapolation Method 1	\$ 16.11
Extrapolation Method 2	\$ 15.95
Extrapolation Method 3	\$ 10.09

Industrial
 (Discounted @ 7.7% Over 40 Years)

	<u>Annuity</u>
Extrapolation Method 1	\$ 13.27
Extrapolation Method 2	\$ 13.93
Extrapolation Method 3	\$ 9.19

FIGURE II.5.2
AGA Projections
Range of Equivalent Annuities

Each of AGA's actual utility and industrial oil and coal price forecasts was extended using the three extrapolation methods cited in the NOPR. The three methods are described in Appendix B. Industrial forecasts were extended to 2020, representing the 40 year physical life of an industrial facility. Utility forecasts were extended 35 years to 2015, representing the physical life of a non-nuclear utility. The discount factor 2.9% was applied to the utility price series, and 7.7% to the industrial price series. The actual series input to the annuity calculations formula are contained in Tables B-17 through B-22 in Appendix B.

The fixed annuity calculation for the actual price forecasts resulted in a reversal of the normal relationship observed between the annuity corresponding to extrapolation method 1 and that corresponding to method 2, in the case of industrial prices. This results from the fact that under method 1 industrial coal prices are extrapolated from 2000 to 2020 at a compound rate of 6.2% per year, while fuel oil prices are extrapolated only at 3.3%. Under method 2, both oil and coal prices are held constant at the year 2000 level. The greater growth rate for coal versus oil under method 1 reduces the annuity to a level below that obtained under method 2.

Table II.5.5 shows the resulting annuities when AGA's world crude price growth assumption is applied to alternative initial year industrial residual prices. Figure II.5.3 graphically depicts the ranges of those annuity values.

TABLE II.5.5
ANNUITIZED INDUSTRIAL FUEL COST DIFFERENCES
BASED ON 3% PER YEAR WORLD CRUDE PRICE ESCALATION
(1980 \$s/BBL Equivalent)

	Using AGA Base Year Price	Using 'Alt 1' Base Price	Using 'Alt 2' Base Price
Extrapolation Method 1	-6.16	-3.96	-1.96
Extrapolation Method 2	-3.52	-1.77	- .178
Extrapolation Method 3	-8.26	-6.51	-4.918

FIGURE II.5.3
AGA Based Projections
Range of Equivalent Annuities
for Industrial Fuel Costs
Assuming 3% per Annum Real Price Growth
1980-2000

The sensitivity of the annuity calculation to relative growth rates in real prices for coal and oil over the forecast period shows up dramatically in the annuitized industrial fuel cost differentials when residual price growth is held at the assumed imported oil growth rate of 3% per year through 2000. The fixed annuities are negative in all initial price cases and for all three extrapolation methods. As was the case with extrapolation of AGA's direct fuel oil and coal price forecasts, a reversing phenomenon occurs in the relationship between the absolute magnitudes of the calculated annuities, and the extrapolation method upon which the annuity is based. Method 3 yields the highest annuities in absolute value in all three initial price cases, a result of the 6.2% per year growth rate from 2000 through 2020 for coal versus 0% for oil. The smallest annuities in absolute value now correspond to extrapolation method 2, where both coal and oil prices are constrained to zero growth from 2000-2020.

INDICATORS AND ASSUMPTIONS UNDERLYING THE FORECAST

Table II.5.6 summarizes key parameters associated with the AGA forecast. Of particular significance is the expected rate of growth in gas industry sales projected through 2000. As a means of comparison, the growth rate in gas supply/demand corresponding to EIA's updated mid-price scenario is included. One reason underlying the disparity in gas consumption growth rates between the two sources is that the AGA forecast includes substantial gas consumption by electric utilities at 1990 (1.5 tcf/yr) and out to 2000 (1.3 tcf/yr). The EIA projection, on the other hand, projects virtually zero gas consumption by utilities after 1990.

TABLE II.5.6

INDICATORS AND ASSUMPTIONS UNDERLYING THE AGA FORECAST

<u>Concept</u>	<u>Value</u>
Gas Sales Growth, Average ¹ Annual Rates, 1980-2000	1.4% per year
(Compare: Sales Growth, EIA Update Mid-Price Scenario, Average Annual Rate, 1980-2000) ²	(-.7% per year)
*Inflation Rates (Measured by GNP Deflator)	1980-1985: 7.4% per year 1985-1990: 6.3% per year 1990-1995: 6.1% per year 1995-2000: 5.7% per year
*Coal Production Cost Escalation	2.8% real through 1990, 5% real 1990-2000
*World Crude Price Escalation	3% per year through 2000
*Real GNP Growth Rate, ³ 1979-1989	2.4% per year

*Principal assumptions underlying the TERA model runs relating to the fuel price trajectories.

¹Excludes direct producer-consumer sales and transportation consumption.
Source: Figure 4, Draft TERA Base Case Analysis, TERA 80-1.

²Includes producer sales to end-users and transportation use.
Source: Draft LEAP output for ARC '80, pg. 5, lines 28, 45.

³Actual income concepts used by TERA for this projection are personal income per household and personal income in manufacturing derived from the Wharton Annual Model Pre-Meeting Solutions, April, 1980. The rate 2.4% per year is the underlying real GNP growth rate for that solution.

II.6 The Chase Manhattan Bank Projections

THE FORECAST

The CMB forecast of oil and coal prices is presented in Table II.6.1. The data are displayed graphically in Figure II.6.1. For the period over which the projection is made, 1980-1990, the CMB imported crude oil price

TABLE II.6.1

CHASE MANHATTAN BANK
OIL AND COAL PRICE PROJECTIONS
(In 1980 dollars)*

Year	Average Contract Price Imported Crude Oil (\$s/BBL)	Domestic Coal FOB the Mine (\$s/MMBTU)
1980	32.99	1.01
1981	40.23	.99
1982	40.97	1.03
1983	42.62	1.08
1984	44.38	1.13
1985	46.54	1.20
1986	48.84	1.20
1987	51.29	1.19
1988	54.13	1.20
1989	56.99	1.20
1990	59.89	1.20

AVERAGE ANNUAL RATES OF PRICE CHANGE
(Percent)

Period	Imported Crude Oil	Domestic Coal
1980-1985	7.1	3.5
1985-1990	5.2	0.0

Source: Crude Oil and Coal Prices, 1980-1990, Chase Manhattan Bank, 1980.

*Original figures expressed in nominal dollars were converted to 1980 dollars using the inflation index accompanying the price forecast. (The Consumer Price Index at an annual rate of 7.7%.)

FIGURE II.6.1
Chase Manhattan Bank Price Projections

trajectory exceeds EIA's updated high price scenario by a modest margin. The coal price forecast, on the other hand, is the lowest of all those presented in Section II.

In terms of compound growth rates, the CMB crude oil price rises at an average of 6.1% per year over its ten year horizon. The equivalent rate corresponding to EIA's updated high price scenario is 4.5% (using \$34.50/BBL as the base year oil price). The coal price, however, exhibits a modest 1.7% growth rate over the projection period, with no real growth after 1985. EIA's low price updated forecast shows coal prices growing at 4.1% per year between 1980 and 1990 (using \$1.87/MMBTU as the base year price).

ANNUITY EQUIVALENT CALCULATIONS

For the alternate fuel cost calculation procedure, two residual fuel oil price series from 1980 to 1990 were developed based on CMB's imported

oil price growth rates and the two alternative 1980 residual fuel oil prices shown in Table II.6.2. Extension of the series to 2020 was done by applying each of the three extrapolation methods described in Appendix B. The last-period-forecast growth rate method of extrapolation produces very high oil prices by 2020 due to the 5.2% compound growth rate exhibited by the CMB oil price forecast for the 1985-1990 period. Tables B-25 and B-26 in Appendix B contain the series actually input to the cost calculation procedure. Table II.6.2 presents the fixed annuities corresponding to these price trajectories. The range of annuities is graphically displayed in Figure II.6.2. Since the CMB coal price forecast exhibits no growth from 1985 to 1990, extrapolation methods 2 and 3 produce the same calculated annuity.

TABLE II.6.2

Annuitized Fuel Cost Difference-CMB
(1980 \$s/BBL Equivalent)

	<u>ALT 1</u>	<u>ALT 2</u>
Extrapolation Method 1	32.04	37.37
Extrapolation Method 2	14.02	16.45
Extrapolation Method 3*	14.02	16.45

*Due to zero real growth in the coal price forecast over the last forecast period, 1985-1990, methods 2 and 3 yield the same annuity.

FIGURE II.6.2
Chase Manhattan Bank Projections
Range of Equivalent Annuities

INDICATORS AND ASSUMPTIONS UNDERLYING THE FORECAST

Table II.6.3 summarizes the principal known assumption which underlies the CMB projection. Unfortunately, since the CMB forecast is an internally generated forecast, published only as an in-house circular, little more is known about the assumptions and methods used in producing it. The assumed CPI rate of 7.7% compares closely to the GNP deflator rates assumed in the DRI and WEFA forecasts.

TABLE II.6.3

Indicators and Assumptions Underlying the CMB Forecast

Concept	Value
Inflation Rate	7.7% per year average annual increase in the Consumer Price Index.

III. The EIA Regional Oil and Coal Price Forecasts

III.1 OVERVIEW

The Mid-Term Energy Forecasting System (MEFS) employed by EIA's Office of Applied Analysis for mid-term projections generates regional energy price and quantity forecasts as well as national aggregate for the years 1985, 1990, and 1995. The demand side of the model is divided into the ten DOE regions shown in Figure III.0. In this section, the regional oil and coal price projections corresponding to EIA's updated high, mid, and low price scenarios are presented along with the results of the annuity calculation procedure.

III.2 THE FORECASTS

Table III.1 contains the regional projections of oil and coal prices associated with the high, mid and, low oil price scenarios. Due to differences in the structural designs of the models employed by EIA for mid and long-term projections, regional price forecasts beyond 1995 are not available. The method adopted for initializing each series at 1980 was to interpolate the 1980 value linearly using 1978 actual regional prices (as provided in the Service Report) and 1985 projected regional prices. Regional price projections were extrapolated from 1995 EIA-provided values to the year 2020 by taking the 1995 value as a base, and applying the corresponding EIA low, mid, and high world crude oil price growth rates.

This method was chosen after an initial exercise was completed using the three extrapolation methods adopted in the NOPR (as described in Appendix B). These three methods were found to excessively distort the underlying EIA description of the long term world crude oil market as contained in the Long Term Chapter of the EIA ARC-80.

FIGURE III.0
DEPARTMENT OF ENERGY REGIONS

TABLE III.1

EIA REGIONAL INDUSTRIAL FUEL PRICE FORECASTS
(In 1980 dollars)

Year	<u>Scenario</u>					
	LOW-RANGE		MID-RANGE		HIGH-RANGE	
	Residual Oil (\$/BBL)	Industrial Coal (\$/MMBTU)	Residual Oil (\$/BBL)	Industrial Coal (\$/MMBTU)	Residual Oil (\$/BBL)	Industrial Coal (\$/MMBTU)
NEW ENGLAND						
1985	39.36	2.93	44.91	2.95	51.31	3.00
1990	40.10	2.54	49.80	2.57	58.46	2.60
1995	40.44	2.55	59.29	2.61	77.72	2.69
NEW YORK/NEW JERSEY						
1985	40.99	2.47	46.01	2.47	52.41	2.51
1990	41.20	2.71	50.90	2.74	59.56	2.76
1995	41.54	2.74	60.39	2.79	78.55	2.87
MID-ATLANTIC						
1985	41.96	2.12	46.98	2.10	53.37	2.12
1990	42.09	2.37	51.86	2.37	60.46	2.38
1995	42.51	2.38	61.28	2.43	79.44	2.49
SOUTH ATLANTIC						
1985	39.34	2.94	44.43	3.01	50.90	3.06
1990	39.69	3.38	49.38	3.48	58.05	3.54
1995	40.03	3.37	58.88	3.48	78.75	3.56
MID-WEST						
1985	39.55	2.16	44.57	2.18	50.97	2.21
1990	39.82	2.37	49.59	2.41	57.84	2.44
1995	39.07	2.35	41.75	2.42	39.75	2.46
SOUTHWEST						
1985	39.62	2.89	45.12	2.99	51.17	3.07
1990	40.03	3.15	49.80	3.22	58.39	3.30
1995	40.37	3.34	59.49	3.45	79.44	3.56

TABLE III.1 (cont'd.)

EIA REGIONAL INDUSTRIAL FUEL PRICE FORECASTS
(In 1980 dollars)

Year	<u>Scenario</u>					
	LOW-RANGE		MID-RANGE		HIGH-RANGE	
	Residual Oil (\$/BBL)	Industrial Coal (\$/MMBTU)	Residual Oil (\$/BBL)	Industrial Coal (\$/MMBTU)	Residual Oil (\$/BBL)	Industrial Coal (\$/MMBTU)
CENTRAL						
1985	39.82	1.85	44.84	1.87	51.24	1.88
1990	40.03	2.05	49.87	2.07	58.53	2.08
1995	39.62	2.06	42.30	2.11	40.30	2.16
NORTH CENTRAL						
1985	38.38	1.42	43.40	1.46	49.80	1.49
1990	38.38	1.42	53.65	1.46	56.88	1.49
1995	38.72	1.47	57.84	1.50	78.13	1.53
WEST						
1985	37.48	2.56	42.44	3.14	48.83	3.23
1990	38.24	3.27	47.53	3.35	56.06	3.45
1995	38.04	3.31	56.81	3.39	76.90	3.45
NORTHWEST						
1985	37.21	2.05	42.09	2.05	48.49	2.08
1990	37.90	2.98	47.18	3.36	55.71	2.99
1995	37.69	3.33	56.47	3.27	76.55	3.16
NATIONAL AVERAGE						
1985	39.34	2.49	44.78	2.54	51.38	2.57
1990	38.72	2.79	49.66	2.88	58.12	2.91
1995	39.69	2.90	51.58	2.98	62.66	3.05

Examination of the regional forecasts reveals substantial interregional variation in the price projections. The oil price is defined as the marginal residual fuel oil price to industry for all grades of residual. Thus defined, the regional oil prices are not directly comparable to EIA's crude oil price concepts presented in Section II.1. Included in the residual price concepts are refining costs, refiners' margins, and shipping costs. Coal prices are defined as the marginal price of steam coal to industry for all coal grades and are, therefore, the regional analogs of EIA's national industrial coal price forecast.

It was viewed as inappropriate to apply the mid-term imported oil price growth rates to regional 1980 estimated residual fuel oil prices because this method, which was utilized to form the residual fuel oil price trajectories in section II of this report, would have obviated the regional variations in trajectories provided by the MEFS model.

III.3 ANNUITY EQUIVALENT CALCULATIONS

Annuities calculated for each region are presented in Figure III.12 for the EIA Low Range Price scenario, in Figure III.2 for the Mid Range scenario, and in Figure III.3 for EIA's High Range scenario. The Regional annuity values substantially exceed the corresponding EIA national annuities discussed in Section II.2, above. This significant difference in the values is attributable to the fact that the regional projections for industrial residual fuel oil escalate very rapidly in the 1980 to 1985 period, in comparison to the world crude oil prices used for deriving the national annuities in Section II.2.

To provide a basis for comparing the regional and corresponding national annuities, averages of the regional residual oil and industrial coal prices

were used to derive a national average annuity value using the data and methodology employed for deriving the regional annuities. These values, for Low, Mid, and High range, respectively, are included in Figures III.1 through III.3, labeled "National Average".

FIGURE III.1

Comparison of Regional Industrial Equivalent Annuities
EIA Low Range Scenario

* Annuities labeled "National Average" are not to be confused with the values calculated and discussed in Section II. The National Average Equivalent Annuities were derived to provide a basis for comparing inter-regional variation, and the derivation is identical to that used for calculating the regional equivalent annuities. U. S. average residual fuel oil prices were extracted from the Service Report, Regional Price Summary Tables, converted to 1980 dollars, and the 1980 value was linearly interpolated from the 1978 given value and the 1985 projection. As with the regional derivations, the national average industrial residual fuel oil price was extrapolated from 1995 to 2020, using the 1995 U. S. average industrial residual fuel oil forecast as a base, and the EIA World Crude Price growth rates from 1995 to 2020. A separate National Average Equivalent Annuity was calculated for each of the EIA scenarios.

FIGURE III.2

Comparison of Regional Industrial Equivalent Annuities
EIA-Mid Range Scenario

*See footnote, Figure III.1.

Special attention should be directed to the anomalies found in the High Scenario Midwest and Central residual fuel oil price projections. Residual fuel oil prices are projected to fall in these regions from 1990 to 1995, notwithstanding the fact that the underlying World Crude Oil projected price is rising at a rate of over 7%. Falling residual fuel oil prices may reflect a trapped market situation for residual fuel oil in these inland regions, where high gasoline and refined product demand, and limited uses for the bottom

end of the crude barrel cause significant discounting in the residual fuel oil market. It should be emphasized that EIA heavily disclaims any reliance on its regional fuel price breakouts associated with the MEFS. EIA's disclaimer reads as follows:

" . . . regional forecasts were made only for the purpose of developing consistent national projections and, as such, does not represent the same level of accuracy as the national level projections. The regional values should not be interpreted as EIA's estimates for a particular region but rather as a guide for projecting consistent national estimates."

FIGURE III.3

Comparison of Regional Industrial Equivalent Annuities
EIA High Range Scenario

*See footnote, Figure III.1.

From Figures III.1 and III.3 it can be concluded that there is substantial regional variation in the fixed annuities applicable to industrial firms, which stem from variations in regional fuel price trajectories. For example, in EIA's mid price scenario the fixed annuities vary from \$14.27 to \$27.55, a range of \$13.28 or 70% of the national average of \$19.02.

IV. Applicability of the Net Present Value Approach for Comparing Alternate Fuel Price Trajectories

The Economic Regulatory Administration, in its interim cost test rules published in 1979, had proposed that the cost of alternative fuels relative to oil be evaluated in terms of the ratio of the present value of costs associated with use of the alternate fuel to the present value of costs using imported oil in a similarly configured facility. Should that ratio meet or exceed 1.3, an exemption from conversion would be considered justified on grounds that costs of using the alternate fuel "substantially exceed" the costs of continued use of oil.

The new cost test methodology proposed in the NOPR bases cost comparisons on the present value of the net difference between alternative incurred cost streams over the period of comparison, as opposed to their ratio. When confined to comparison of alternate unit fuel cost trajectories, the present value of the net difference can be converted to a single levelized unit fuel cost over the period of comparison. ("Levelization" is the standard term employed in the utility industry for the process of converting a present worth to a uniform annual payment equivalent, or annuity*).

* Ref. EPRI Technical Assessment Guide, July, 1979, pps. 3-6 ff.

The actual procedure employed seeks the solution to the following problem:

$$\sum_{i=1}^n \frac{C}{(1+k)^i} = \sum_{i=1}^n \frac{(PA_i - PB_i)}{(1+k)^i} \quad (1)$$

where PA_i and PB_i are the prices of oil and the alternate fuel in period i , k is the discount rate, and n is the number of years relevant to the calculation. "C" is a constant to be solved for given all other parameter values in the relationship.

The equation is implemented for the calculations made in this study based on a variation of (1):

Solve for Δ in:

$$\sum_{i=1}^n \frac{(PA + \Delta) - PB}{(1+k)^i} = \sum_{i=1}^n \left(\frac{PA * fA(i)}{(1+k)^i} - \frac{PB * fB(i)}{(1+k)^i} \right)$$

where PA and PB are initial period prices of oil and the alternate fuel, $fB(i)$ and $fA(i)$ are the ratios of i^{th} period prices to corresponding base period prices, and k is the discount rate. Delta () is interpreted as the fixed annuity equivalent of the unit fuel cost differentials.

Isolating Δ on the left yields:

$$\Delta = PA \left[\frac{\sum_{i=1}^n fA(i)(1+k)^{-i}}{n \cdot (1+k)^{-1}} - 1 \right] - PB \left[\frac{\sum_{i=1}^n fB(i)(1+k)^{-1}}{n \cdot (1+k)^{-1}} - 1 \right] \quad (2)$$

Appendix C contains a listing of the FORTRAN program which implements equation 2.

Relationships (1) and (2) are consistent with recommended procedures in the Electric Power Research Institute's Technical Assessment Guide for comparison of alternative costs in the electric utility sector. For calculation of the fuel component of costs, EPRI uses the formula*

$$\text{Levelized Annual Fuel Cost} = (\text{Fuel Cost } (\$/10^6 \text{ BTU}) * \text{Heat Rate} \\ (\text{BTU/KWH} * \text{Levelizing Factor}) / 1000$$

The result of this calculation is the annuitized fuel cost expressed in mills/kwh. The levelizing factor used by EPRI differs from

$$\left(\sum_{i=1}^n (1+k)^{-i} \right)^{-1}$$

of formulae (1) and (2) in that a capital recovery factor is also accounted for.

In the context of the revised cost test methodology documented in the NOPR, formula (2) is correctly used for computation of annuitized fuel cost differentials. It is consistent with prevailing practice in industry and the utility sector when comparing alternatives in a dynamic setting.

The formula furnished by the government and used to calculate the levelized unit fuel cost differences associated with the forecasts in section II-1 through II-6 and section III is therefore validly applied in this context.

* EPRI Technical Assessment Guide, July, 1979, Exhibit 3-3, pg. 3-9.

APPENDIX A

LIST OF REFERENCES AND CONTACTS SEARCHED FOR
ALTERNATIVE OIL AND COAL PRICE FORECASTS

References and Contacts Searched For
Alternative Price Forecasts

The following sources provided alternative forecasts for use in this report:

- o The American Gas Association
TERA Base Case Analysis, November 21, 1980
- o The Electric Power Research Institute
Technical Assessment Guide, July, 1979
- o The Chase Manhattan Bank

The following sources were contacted or searched but did not have prepared forecasts of oil and coal prices which are published, or which substantively enhance the information base:

- o Congressional Budget Office
The World Oil Market in the 1980's: Implications for the United States, May, 1980
The CBO assumes a real oil price growth rate of 2% per year from 1980 through 1990. No assumption is made regarding coal prices, and there is no coal price forecast.
- o Congress of the United States
Office of Technology Assessment
Energy Materials and International Security Division
World Petroleum Availability, 1980-2000
No price projections are contained in this report.
- o The Petroleum Industry Research Foundation, (Gary Ross, Larry Goldstein)
The American Petroleum Institute, (Dr. Ed Murphy)
Shell Oil Co., U.S. National Energy Outlook, 1980 to 1990, Feb., 1980, and
The Oil Shale Corp. (TOSCO) (Bill Gillespie)
Private companies and petroleum industry associations do not disseminate either projections or assumptions about future oil prices for reasons concerning the anti-trust laws. They do make projections, however, of energy consumption and production levels.
- o The Central Intelligence Agency (Mr. Leo Hazelwood)
The CIA prepares in-house forecasts of oil and coal prices, but does not make them available to the public.
- o The Committee on Nuclear and Alternative Energy Strategies,
Energy in Transition, 1980-2010, 1979
- CONAES assumes that energy prices in year 2010 will be certain multiples of 1975 prices, depending on the scenario. CONAES was not used as a source forecast because the study was actually completed in 1978 and its price forecasts were out of date.

- o Bureau of Economic Analysis, U.S. DOC (Mr. Harry Townsend)
BEA uses EIA's price forecasts for their model runs.
- o The World Bank (Mr. Adrian Lambertini, Mr. John Strongman)
No energy price projections are published. For internal analyses, a real price growth assumption is made, such as 3% per year.
- o U.S. State Department, Office of Energy (Mr. Dan Dolan)
No price forecasts are made or published. Mr. Dolan expressed the view that Government generated and published forecasts of oil prices provide a rationale for subsequent OPEC price policy.
- o MIT Energy Lab (Ms. Martha Mason)
No independent price forecasts are made.
- o Office of International Oil Policy, Policy and Evaluation (P&E), U.S. Department of Energy (Mr. Mike Barron)
P & E purchased a study by Steven Salant and ICF which included running alternative scenarios with a model of OPEC price policy developed by Salant. The Salant model is included in the World Oil Price Forecasting Model Study Conducted by the Energy Modeling Forum (discussed below and in Appendix D).
- o U.S. International Trade Commission (Mr. John Gersic)
No internal forecasts are prepared.
- o Evans Economics, Inc. (Mr. Dave Ernst, Ms. Rebecca Schillingberg)
Nominal world oil prices (FOB OPEC) are projected to rise at 14% per year through 1985, and nominal coal prices at 10% through 1982. This information was provided verbally and underlies short-term macro-economic projections produced by Evans's supply-side model. No documentation is available.
- o Harris Trust & Savings (Mr. Beryl Sprinkel)
HT&S makes short run macro-economic forecasts using a model which emphasizes resolution of U.S. financial markets and monetary factors. Energy prices are embedded in a general index of inflation.
- o Edison Electric Institute (Mr. Jerry Karaganis)
No internal forecasts are prepared.

The following sources prepare forecasts of energy prices, but make them available only to subscribers or paying clients:

- o Chase Econometrics (Messrs. Larry Horowitz, Buff Brown)
Chase has only recently developed an energy sector forecasting model which is not yet used for production purposes. Their forecasts are furnished to subscribers for about \$8,000 per year.

- o PACE, Inc. (Mr. Richard Grissom)
PACE serves clients in the refining and petrochemical industries. They prepare semi-annual price and volume projections through 2000 for subscribers at a cost of approximately \$18,000 per year. PACE does not publish coal prices.
- o Teknekron, Inc. (Mr. Ron Davis)
Teknekron provides projections for utility and other private sector clients based on specifications provided by the client.
- o Decision Focus, Inc. (Mr. Ed Cazalett)
DFI prepares forecasts based on client specifications. No in-house projection is prepared and published independently.
- o Zinder Associates, Inc. (Dr. John Neri)
Zinder serves the gas utility industry, and provides forecasts geared to the needs of the client on an as-needed basis.

The following sources provided published projections, but of world oil prices only (These sources are discussed more fully in Appendix D):

- o Virginia Polytechnic Inst. & State U. (Dr. David Hirshfeld, et al)
OPEC Policies, Revenue, and World Energy Supplies, Feb., 1980.
Real world oil price growth rates ranging from 0% to 7.5% per year through 2000 are assumed for various model runs.
- o Energy Modeling Forum (Tim Shaftel)
World Oil Graphics, Nov. 14, 1980
Ten different models are exercised over twelve different scenarios for comparison of model oil price forecasts through 2020. Final report will not be published until Spring, 1981.
- o MIT (Prof. Robt. S. Pindyck)
"Gains to Producers From the Cartelization of Exhaustible Resources", Review of Economics and Statistics, May, 1978, pps. 238-250.
Pindyck forecasts OPEC oil prices through 2010 assuming maximization of the present value of profits by cartel members.

APPENDIX B

UNADJUSTED FORECASTS AND DERIVED PRICE SERIES

INPUT TO ANNUITY FORMULA

Extrapolation Methods

Method

- 1 Extend oil and coal price forecasts through 2020 using growth rate over last forecast period.*
- 2 Oil and coal prices remain constant at last forecast year value through 2020.
- 3 Oil price remains constant at last forecast year value through 2020; coal price grows at rate of last forecast period.*

*: The last forecast period is defined as the interval between the last two forecast years in the projection, with a minimum 25 years being used when each year is provided such as in the CMB forecast.

TABLE B-1

UNADJUSTED PRICE FORECASTS
ENERGY INFORMATION ADMINISTRATION

WORLD OIL PRICE ^{1/}
(1979 \$/BBL)

<u>Year</u>	Scenario ^{2/}			
	<u>High</u>		<u>Mid</u>	<u>Low</u>
1985	43.00		37.00	32.00
1990	49.00		41.00	32.00
1995	70.00		50.00	32.00
2000	(16.03) 92.97	(10.33)	59.91	(7.24) 41.99
2010	(19.31) 112.00	(12.40)	71.92	(8.45) 49.01
2020	(23.10) 133.98	(14.81)	85.90	(10.00) 58.00

Industrial Coal Price ^{1/}
(1979 \$/MMBTU)

<u>Year</u>	Scenario		
	<u>High</u>	<u>Mid</u>	<u>Low</u>
1985	2.56	2.56	2.56
1990	2.65	2.66	2.66
1995	2.72	2.73	2.73
2000	2.79	2.82	2.81
2010	2.94	2.99	2.99
2020	3.29	3.38	3.40

^{1/} 1985, 1990, and 1996 price forecasts are contained in the 1980 Annual Report to Congress Service Report, SR/IA/80-16. The 2000, 2010, and 2020 price projections are contained in LEAP model solution tables.

^{2/} Figures in parentheses are forecast prices in \$/MMBTU as reported in LEAP model solution tables.

- 1/ Sources: 1985-1995, Table 2.1 from draft of Chapter 2, 1980 Annual Report to Congress; 2000-2020, draft results from computer outputs of Long-Range Energy Analysis Program (LEAP), Version 1980.1.0, generated on 11/25/80, page 21.
- 2/ Figures in parentheses are as reported in LEAP output, 1979 \$\$/MMBTU. The factor 5.8 is used to convert \$\$/MMBTU to \$\$/BBL crude equivalent.
- 3/ Draft results from computer outputs of LEAP, Version 1980.1.0, generated on 11/25/80, page 22.
- * To convert to 1980 \$\$, multiply entries by 1.094. See
 Section II for sources of GNP deflator values.

TABLE B-2

EIA - HIGH Projection
Residual Fuel Oil Price
(1980 \$/BBL)

	<u>ALT 1</u> *	<u>ALT 2</u> *
1980	25.64	29.77
1985	34.96	40.60
1990	39.75	46.16
1995	56.80	65.96
2000	75.30	87.44
2010	90.89	105.55
2020	108.64	126.16

Industrial COAL Price
(1980 \$/MMBTU)

1980	1.87
1985	2.57
1990	2.91
1995	3.05
2000	3.05
2010	3.22
2020	3.60

* See Table II.0.2 in Section II for derivation of lower initial residual price (ALT 1), and higher initial residual price (ALT 2).

TABLE B-3

EIA - MID Projection

Residual Fuel OIL Price
(1980 \$/BBL)

	<u>ALT 1</u> *	<u>ALT 2</u> *
1980	25.64	29.77
1985	30.01	34.85
1990	33.30	38.67
1995	40.71	47.27
2000	48.82	56.69
2010	58.35	67.76
2020	69.75	81.00

Industrial COAL Price
(1980 \$/MMBTU)

1980	1.87
1985	2.54
1990	2.88
1995	2.98
2000	3.09
2010	3.27
2020	3.70

* See Table II.0.2 in Section II for derivation of lower initial residual price (ALT 1), and higher initial residual price (ALT 2).

TABLE B-4

EIA - LOW Projection

Residual Fuel OIL Price
(1980 \$/BBL)

	<u>ALT 1</u> *	<u>ALT 2</u> **
1980	25.64	29.77
1985	25.90	30.07
1990	25.90	30.07
1995	25.90	30.07
2000	34.17	39.67
2010	40.05	46.49
2020	47.40	55.03

Industrial COAL Price
(1980 \$/MMBTU)

1980	1.87
1985	2.49
1990	2.79
1995	2.90
2000	3.07
2010	3.27
2020	3.72

* See Table II.0.2 in Section II for derivation of lower initial residual price (ALT 1), and higher initial residual price (ALT 2).

TABLE B-5
UNADJUSTED PRICE FORECAST
DATA RESOURCES, INC.

<u>Year</u>	<u>Marginal Price of Imported Oil ^{1/}</u> <u>(Nominal \$/BBL)</u>
1980	36.15
1985	63.96
1990	112.73
1995	188.39
2000	282.71

<u>Year</u>	<u>New Contract Price of Coal ^{1/}</u> <u>(Nominal \$/Short Ton)</u>
1980	33.73
1985	63.13
1990	100.18
1995	151.22
2000	212.92

^{1/} Source: Series 'MPMCRUDE' and 'PNEWCONTRACT' extracted from energy model solution data base '@ENG/E1180', the November, 1980 scenario.

TABLE B-6

DRI Projections
Extrapolation Method 1
Residual Fuel OIL Price
(1980 \$/BBL)

	<u>ALT 1</u> ^{***}	<u>ALT 2</u> ^{***}
1980	25.64	29.77
1985	30.16	35.02
1990	36.52	42.40
2000	49.79	57.80
2010	63.12	73.27
2020	80.01	92.88

New Contract COAL Price
(1980 \$/MMBTU)

1980	1.50
1985	1.87
1990	2.03
1995	2.23
2000	2.35
2010	2.62
2020	2.92

* See Table II.0.2 in Section II for derivation of lower initial residual price (ALT 1), and higher initial residual price (ALT 2).

TABLE B-7
DRI Projections
Extrapolation Method 2
Residual Fuel OIL Price
(1980 \$/BBL)

	<u>ALT 1</u> *	<u>ALT 2</u> *
1980	25.64	29.77
1985	30.16	35.02
1990	36.52	42.40
1995	44.22	51.34
2000	49.79	57.80
2010	49.79	57.80
2020	49.79	57.80

New Contract COAL Prices
(1980 \$/MMBTU)

1980	1.50
1985	1.87
1990	2.03
1995	2.23
2000	2.35
2010	2.35
2020	2.35

* See Table II.0.2 in Section II for derivation of lower initial residual price (ALT 1), and higher initial residual price (ALT 2).

TABLE B-8

DRI Projection
Extrapolation Method 3
Residual Fuel OIL Price
(1980 \$/BBL)

	<u>ALT 1</u> *	<u>ALT 2</u> *
1980	25.64	29.77
1985	30.16	35.02
1990	36.52	42.40
1995	44.22	51.34
2000	49.79	57.80
2010	49.79	57.80
2020	49.79	57.80

New Contract COAL Prices
(1980 \$/MMBTU)

1980	1.50
1985	1.87
1990	2.03
1995	2.23
2000	2.35
2010	2.62
2020	2.92

* See Table II.0.2 in Section II for derivation of lower initial residual price (ALT 1), and higher initial residual price (ALT 2).

TABLE B-9

UNADJUSTED PRICE FORECAST
WHARTON ECONOMETRIC FORECASTING ASSOCIATES

<u>Year</u>	<u>Imported Oil¹</u> <u>(Nominal \$/BBL)</u>	<u>Domestic Coal¹</u> <u>(Nominal \$/Short Ton)</u>
1980	32.25	27.47
1985	59.87	42.24
1990	92.11	62.06

TABLE B-10

WEFA PROJECTIONS
EXTRAPOLATION METHOD 1 - RESIDUAL FUEL OIL PRICES
(1980 \$/BBL)

<u>Year</u>	<u>ALT 1*</u>	<u>ALT 2*</u>	<u>Domestic Coal Price</u> <u>(1980 \$/MMBTU)</u>
1980	25.64	29.77	1.22
1985	32.41	37.63	1.28
1990	34.57	40.14	1.30
1995	36.88	42.82	1.32
2000	39.34	45.67	1.34
2010	44.76	51.97	1.38
2020	50.94	59.13	1.42

¹Source: Wharton Annual Pre-Meeting Solutions, Oct., 1980, Table 24.52.

*See Table II.0.2 in Section II for derivation of the lower initial residual price (Alt 1), and the higher initial residual price (Alt 2).

TABLE B-11

WEFA Projections

Extrapolation Method 2

Residual Fuel OIL Prices
(1980 \$/BBL)

	<u>ALT 1</u> *	<u>ALT 2</u> *
1980	25.64	29.77
1985	32.41	37.63
1990	34.57	40.14
1995	34.57	40.14
2000	34.57	40.14
2010	34.57	40.14
2020	34.57	40.14

Domestic COAL Price
(1980 \$/MMBTU)

1980	1.22
1985	1.28
1990	1.30
1995	1.30
2000	1.30
2010	1.30
2020	1.30

* See Table II.0.2 in Section II for derivation of lower initial residual price (ALT 1), and higher initial residual price (ALT 2).

TABLE B-12

WEFA Projections

Extrapolation Method 3

Residual Fuel OIL Prices
(1980 \$/BBL)

	<u>ALT 1</u> *	<u>ALT 2</u> *
1980	25.64	29.77
1985	32.41	37.63
1990	34.57	40.14
1995	34.57	40.14
2000	34.57	40.14
2010	34.57	40.14
2020	34.57	40.14

Domestic COAL Price
(1980 \$/MMBTU)

1980	1.22
1985	1.28
1990	1.30
2000	1.32
2010	1.38
2020	1.42

* See Table II.0.2 in Section II for derivation of lower initial residual price (ALT 1), and higher initial residual price (ALT 2).

TABLE B-13

UNADJUSTED PRICE FORECAST

ELECTRIC POWER RESEARCH
INSTITUTE

Fuel Oil Prices - Delivered to Electric ^{1/}
Utilities
(End-of-Year 1978 \$/MMBTU)

<u>Year</u>	<u>Residual</u>			<u>Distillate</u>
	<u>0-.3%*</u>	<u>.31-1.0%*</u>	<u>1.0%+*</u>	
1980	4.30	3.94	3.53	4.76
1985	4.40	4.03	3.61	4.88
1990	4.87	4.46	3.99	5.34
1995	5.56	5.05	4.52	5.97
2000	6.44	5.90	5.28	6.87
2010	7.36	6.74	6.04	7.76
2020	8.65	7.92	7.09	9.00

^{1/} Source: Technical Assessment Guide, EPRI PS-1201-SR, July, 1979. Oil prices, pg. 5-2 (Exhibit 5-1) Coal Prices, pps. 6-3 to 6-5 (Exhibit 6-1).

* Refers to percent sulfur content.

TABLE B-13 (Cont.)

UNADJUSTED PRICE FORECAST
ELECTRIC POWER RESEARCH
INSTITUTE

Delivered Coal Prices for Electric Utilities ^{1/}
(END-OF-YEAR 1978 ~~1978~~ \$\$/MMBTU, First Year of New Contract)

Year	<u>Consuming Region</u>							
	<u>NE</u>	<u>MA</u>	<u>SE</u>	<u>RC</u>	<u>WC</u>	<u>SC</u>	<u>MTN</u>	<u>PAC</u>
1980	1.30	1.45	1.52	1.46	1.00	1.08	.63	1.29
1985	1.50	1.65	1.63	1.53	1.13	1.12	.81	1.29
1990	1.70	1.85	1.74	1.61	1.29	1.18	1.01	1.28
1995	1.71	1.91	1.78	1.67	1.35*	1.30	1.13	1.42
2000	1.82	1.92	1.81	1.70	1.41	1.44	1.24	1.49
2010	2.03	2.04	1.96	1.85	1.61	1.61	1.45	1.61
2020	2.28	2.22	2.16	2.06	1.88	1.84	1.69	1.81

Key: NE - New England
MA - Mid-Atlantic
SE - Southeast
EC - East Central

WC - West Central
SC - South Central
MTN - Mountain
PAC - Pacific

* Omitted in original source. Interpolated by authors.

^{1/}Source: Technical Assessment Guide, EPRI PS-1201-SR, July, 1979. Oil prices, pg. 5-2 (Exhibit 5-1) Coal Prices, pps. 6-3 to 6-5 (Exhibit 6-1).

TABLE B-14

Electric Power Research Institute Projections

Utility Oil Prices for #6 Residual

By Sulfur Content
(1980 \$/BBL)

	<u>Lo Sulfur</u>	<u>Mid-Sulfur</u>	<u>Hi Sulfur</u>
1980	29.63	27.16	24.33
1985	30.33	27.78	24.88
1990	33.57	30.74	27.50
1995	38.32	34.81	31.15
2000	44.35	40.66	36.39
2010	50.73	46.45	41.63
2015	55.00	50.36	45.10

Utility Coal Price
(1980 \$/MMBTU)

1980	1.33
1985	1.46
1990	1.59
1995	1.68
2000	1.75
2010	1.94
2015	2.06

TABLE B-15
UNADJUSTED PRICE FORECASTS
American Gas Association

<u>Year</u>	<u>Oil Prices ^{1/}, ^{2/}</u> <u>(Nominal \$/MMBTU)</u>	
	<u>To Industry</u> (#6 Fuel Oil)	<u>To Utilities</u> (Volume Weighted Average)
1980	3.36	3.96
1985	8.65	9.01
1990	14.56	14.99
1995	23.22	23.74
2000	36.06	36.72

<u>Year</u>	<u>Coal Prices ^{1/}, ^{2/}</u> <u>(Nominal \$/MMBTU)</u>	
	<u>To Industry</u>	<u>To Utilities</u>
1980	1.63	1.32
1985	3.97	3.16
1990	5.63	4.43
1995	10.72	8.39
2000	19.13	14.97

^{1/} Source: TERA BASE CASE ANALYSIS, AGA, November 21, 1980, Figure 2.

^{2/} Assumed average rates of U.S. inflation are:
 1980-1985: 7.4%
 1985-1990: 6.3%
 1990-1995: 6.1%
 1995-2000: 5.7%

Source: Same as ^{1/}, Figure 2, footnote 1.

TABLE B-16

AGA PRICE DEFLATOR
VALUES

<u>Year</u>	<u>Deflator Value</u>	<u>Based On</u>
1980	1.00	
1985	1.43	(80-85 inflation rate 7.4%/yr.)
1990	1.94	(85-90 inflation rate 6.3%/yr.)
1995	2.61	(90-95 inflation rate 6.1%/yr.)
2000	3.44	(95-2000 inflation rate 5.7%/yr.)

TABLE B-17

American Gas Association

Extrapolation Method 1

Average Delivered Fuel Oil Price
to Utilities
(1980 $\$/BBL$)

1980	23.98
1985	38.16
1990	46.79
1995	55.08
2000	64.64
2010	89.43
2015	105.20

Delivered Coal Price to Utilities
(1980 $\$/MMBTU$)

1980	1.32
1985	2.21
1990	2.28
1995	3.21
2000	4.35
2010	8.01
2015	10.87

TABLE B-18

American Gas Association Projection
Extrapolation Method 2Average Delivered Fuel Oil Price
to Utilities
(1980 \$/BBL)

1980	23.98
1985	38.16
1990	46.79
1995	55.08
2000	64.64
2010	64.64
2015	64.64

Average Delivered Coal Price
to Utilities
(1980 \$/MMBTU)

1980	1.32
1985	2.21
1990	2.28
1995	3.21
2000	4.35
2010	4.35
2015	4.35

TABLE B-19

American Gas Association Projection

Extrapolation Method 3

Average Delivered Fuel Oil Price
to Utilities
(1980 \$/BBL)

1980	23.98
1985	38.16
1990	46.79
1995	55.08
2000	64.64
2010	64.64
2015	64.64

Delivered Coal Price
to Utilities
(1980 \$/MMBTU)

1980	1.32
1985	2.21
1990	2.28
1995	3.21
2000	4.35
2010	8.01
2015	10.87

TABLE B-20

American Gas Association Projection

Extrapolation Method 1

Residual Fuel Oil Price
to Industry
(1980 \$/BBL)

1980	21.12
1985	38.03
1990	47.18
1995	55.93
2000	65.90
2010	91.18
2020	126.15

Delivered Coal Price to Industry
(1980 \$/MMBTU)

1980	1.63
1985	2.78
1990	2.90
1995	4.11
2000	5.56
2010	10.15
2020	18.52

TABLE B-21

American Gas Association Projection
Extrapolation Method 2

Average Delivered Fuel Oil Price
to Industry
(1980 \$/BBL)

1980	21.12
1985	38.03
1990	47.18
1995	55.93
2000	65.90
2010	65.90
2020	65.90

Delivered Coal Price to Industry
(1980 \$/MMBTU)

1980	1.63
1985	2.78
1990	2.90
1995	4.11
2000	5.56
2010	5.56
2020	5.56

TABLE B-22

American Gas Association Projection

Extrapolation Method 3

Average Delivered Fuel Oil Price
to Industry
(1980 \$/MMBTU)

1980	21.12
1985	38.03
1990	47.18
1995	55.93
2000	65.90
2010	65.90
2020	65.90

Delivered Coal Price to Industry
(1980 \$/MMBTU)

1980	1.63
1985	2.78
1990	2.90
1995	4.11
2000	5.56
2010	10.15
2020	18.52

TABLE B-23
AMERICAN GAS ASSOCIATION
Oil and Coal Price Projections and
Extrapolations Assuming 3% Per Year Growth
in Fuel Oil Prices

Industrial Fuel Oil
(1980 \$/BBL)

Year	AGA	EM1*		AGA	EM2*		AGA	EM3*	
		Alt 1	Alt 2		Alt 1	Alt 2		Alt 1	Alt 2
1980	21.12	25.64	29.77	21.12	25.64	29.77	21.12	25.64	29.77
1985	24.48	29.72	34.51	24.48	29.72	34.51	24.48	29.72	34.51
1990	28.38	34.46	40.01	28.38	34.46	40.01	28.38	34.46	40.01
1995	32.90	39.95	46.38	32.90	39.95	46.38	32.90	39.95	46.38
2000	38.15	46.31	53.77	38.15	46.31	53.77	38.15	46.31	53.77
2010	51.27	62.24	72.26	38.15	46.31	53.77	38.15	46.31	53.77
2020	68.90	83.64	97.11	38.15	46.31	53.77	38.15	46.31	53.77

Industrial Coal
(1980 \$/MMBTU)

Year	AGA	Alt 1	Alt 2	AGA	Alt 1	Alt 2	AGA	Alt 1	Alt 2
1980	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63
1985	2.78	2.78	2.78	2.78	2.78	2.78	2.78	2.78	2.78
1990	2.90	2.90	2.90	2.90	2.90	2.90	2.90	2.90	2.90
1995	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11
2000	5.56	5.56	5.56	5.56	5.56	5.56	5.56	5.56	5.56
2010	10.15	10.15	10.15	5.56	5.56	5.56	10.15	10.15	10.15
2020	18.52	18.52	18.52	5.56	5.56	5.56	18.52	18.52	18.52

* EM1, EM2, and EM3 correspond to extrapolation methods 1, 2, and 3, respectively. 'ALT 1' indicates 1980 price is lower of two neutral residual oil prices. 'ALT 2' indicates 1980 price is the higher of the two initial prices. See Table II.0.2 in Section II.

TABLE B-24

Unadjusted Price Forecasts
 Chase Manhattan Bank
 (Figures expressed in current \$s)

<u>Year</u>	<u>Average Contract Price Imported Crude Oil (\$/BBL)</u>	<u>Domestic Coal FOB the Mine (\$/MMBTU)</u>	<u>Consumer Price Index (1967=100)</u>
1980	32.99	1.01	246.3
1981	43.85	1.08	269.3
1982	48.34	1.21	291.3
1983	54.13	1.37	313.5
1984	60.80	1.55	337.0
1985	68.41	1.76	362.3
1986	77.17	1.89	389.2
1987	87.19	2.03	417.9
1988	98.52	2.18	448.3
1989	111.13	2.34	481.0
1990	125.77	2.51	516.1

Source: Crude Oil and Coal Prices, 1980-1990, Chase
 Manhattan Bank, 1980.

TABLE B-25

Chase Manhattan Bank Projection

Extrapolation Method 1

	Residual Fuel Oil Prices (1980 \$/BBL)	
	<u>ALT 1</u> *	<u>ALT 2</u> *
1980	25.64	29.77
1985	36.13	41.95
1990	46.55	54.05
1995	59.98	69.64
2000	77.28	89.73
2010	128.30	148.97
2020	213.00	247.32

Coal Price
(1980 \$/MMBTU)

1980	1.01
1985	1.20
1990	1.20
1995	1.20
2000	1.20
2010	1.20
2020	1.20

* See Table II.0.2 in Section II for derivation of lower initial residual price (ALT 1), and higher initial residual price (ALT 2).

TABLE B-26

Chase Manhattan Bank
ProjectionsExtrapolation Method 2 $\frac{1}{2}$

Residual Fuel Oil Prices (1980 \$/BBL)		
	<u>ALT 1</u> *	<u>ALT 2</u> *
1980	25.64	29.77
1985	36.13	41.95
1990	46.55	54.05
1995	46.55	54.05
2000	46.55	54.05
2010	46.55	54.05
2020	46.55	54.05

Coal Prices
(1980 \$/MMBTU)

1980	1.01
1985	1.20
1990	1.20
1995	1.20
2000	1.20
2010	1.20
2020	1.20

 $\frac{1}{2}$ Equivalent also to results of extrapolation method 3.

* See Table II.0.2 in Section II for derivation of lower initial residual price (ALT 1), and higher initial residual price (ALT 2).

TABLE B-27

EIA REGIONAL PROJECTIONS
INPUT TO COST CALCULATION

PROCEDURE ¹
(1980 \$s)

Year	Scenario					
	Low-Range		Mid-Range		High-Range	
	Residual Oil (\$/BBL)	Industrial Coal (\$/MMBTU)	Residual Oil (\$/BBL)	Industrial Coal (\$/MMBTU)	Residual Oil (\$/BBL)	Industrial Coal (\$/MMBTU)
			NEW ENGLAND			
1980	23.87	2.35	25.24	2.36	27.10	2.37
1985	39.36	2.93	44.91	2.95	51.31	3.00
1990	40.10	2.54	49.80	2.57	58.46	2.60
1995	40.44	2.55	59.29	2.61	77.72	2.69
2000	53.30	2.70	71.05	2.71	103.10	2.69
2010	62.18	2.88	85.29	2.87	124.22	2.84
2020	73.59	3.27	101.86	3.25	148.56	3.17
			NY/NJ			
1980	24.00	1.86	25.45	1.86	27.24	1.87
1985	40.99	2.47	46.01	2.47	52.41	2.51
1990	41.20	2.71	50.90	2.74	59.56	2.76
1995	41.54	2.74	60.39	2.79	78.55	2.87
2000	54.75	2.90	72.36	2.89	104.20	2.87
2010	63.90	3.09	86.87	3.06	125.52	3.03
2020	75.25	3.51	103.72	3.47	150.15	3.38

¹1980 prices were linearly interpolated from EIA regional 1978 Demand Regional Retail Prices summarized on page A-135 of the Service Report (Series B - ARCBO BASE CASE). Regional price projections for 2000, 2010, and 2020 were derived using the compound growth rates for the EIA national crude oil price projections, by scenario, applied to the regional 1995 projected price. All prices were converted from 1979 to 1980 dollars using the G. N. P. deflator (1.094).

13-81

TABLE B-27 (Cont'd)

EIA REGIONAL PROJECTIONS
INPUT TO COST CALCULATION
PROCEDURE
(1980 \$s)

Scenario

Year	Low-Range		Mid-Range		High-Range	
	Residual Oil (\$/BBL)	Industrial Coal (\$/MMBTU)	Residual Oil (\$/BBL)	Industrial Coal (\$/MMBTU)	Residual Oil (\$/BBL)	Industrial Coal (\$/MMBTU)
MID ATLANTIC						
1980	24.14	1.58	25.59	1.56	27.37	1.58
1985	41.96	2.12	46.98	2.10	53.37	2.12
1990	42.09	2.37	51.86	2.37	60.46	2.38
1995	42.51	2.38	61.28	2.43	79.44	2.49
2000	55.99	2.53	73.46	2.52	105.37	2.49
2010	65.34	2.69	88.18	2.67	126.97	2.64
2020	77.31	3.06	105.30	3.02	151.87	2.94
SOUTH ATLANTIC						
1980	23.25	1.93	24.69	1.95	26.55	1.96
1985	39.34	2.94	44.43	3.01	50.90	3.06
1990	39.69	3.38	49.38	3.48	58.05	3.54
1995	40.03	3.37	58.88	3.48	78.75	3.56
2000	52.75	3.57	70.57	3.61	104.48	3.56
2010	61.56	3.80	84.67	3.82	125.87	3.75
2020	72.84	4.32	101.18	4.32	150.56	4.20
MIDWEST						
1980	25.86	1.66	27.31	1.67	29.23	1.93
1985	39.55	2.16	44.57	2.18	50.97	2.21 2.22
1990	39.82	2.37	49.59	2.41	57.84	2.44 2.44
1995	39.07	2.35	41.75	2.42	39.75	2.46 2.46
2000	51.45	2.49	50.07	2.51	52.82	2.46 2.46
2010	60.04	2.65	60.04	2.66	63.62	2.60 2.60
2020	71.05	3.02	71.74	3.00	76.07	2.91 2.91

TABLE B-27 (Cont'd)

EIA REGIONAL PROJECTIONS
INPUT TO COST CALCULATION
PROCEDURE
(1980 \$s)
Scenario

Year	Low-Range		Mid-Range		High-Range	
	Residual Oil (\$/BBL)	Industrial Coal (\$/MMBTU)	Residual Oil (\$/BBL)	Industrial Coal (\$/MMBTU)	Residual Oil (\$/BBL)	Industrial Coal (\$/MMBTU)
	SOUTHWEST					
1980	22.35	2.19	23.87	2.21	25.65	2.24
1985	39.62	2.89	45.12	2.99	51.17	3.07
1990	40.03	3.15	49.80	3.22	58.39	3.30
1995	40.37	3.34	59.49	3.45	79.44	3.56
2000	53.17	3.53	71.32	3.58	105.37	3.56
2010	62.04	3.76	85.56	3.79	126.97	3.75
2020	72.77	4.28	102.21	4.28	151.87	4.20
	CENTRAL					
1980	24.90	1.54	26.34	1.55	28.13	1.55
1985	39.82	1.85	44.84	1.87	51.24	1.88
1990	40.03	2.05	49.87	2.07	58.53	2.08
1995	39.62	2.06	42.30	2.11	40.30	2.16
2000	52.20	2.18	50.69	2.19	53.44	2.16
2010	60.87	2.32	60.87	2.32	64.38	2.28
2020	72.08	2.64	72.70	2.63	77.03	2.55
	NORTH CENTRAL					
1980	21.73	1.13	23.18	1.14	24.97	1.15
1985	38.38	1.42	43.40	1.46	49.80	1.49
1990	38.38	1.42	53.65	1.46	56.88	1.49
1995	38.72	1.47	57.84	1.50	78.13	1.53
2000	51.03	1.55	69.33	1.55	103.65	1.53
2010	59.49	1.65	83.22	1.64	124.84	1.62
2020	70.43	1.88	99.39	1.86	149.32	1.81

TABLE B-27 (Cont'd)

EIA REGIONAL PROJECTIONS
 INPUT TO COST CALCULATION
 PROCEDURE
 (1980 \$s)

Scenario

Year	Low-Range		Mid-Range		High-Range	
	Residual Oil (\$/BBL)	Industrial Coal (\$/MMBTU)	Residual Oil (\$/BBL)	Industrial Coal (\$/MMBTU)	Residual Oil (\$/BBL)	Industrial Coal (\$/MMBTU)
			WEST			
1980	22.01	2.56	23.45	2.59	25.24	2.61
1985	37.48	3.04	42.44	3.14	48.83	3.23
1990	38.24	3.27	47.53	3.35	56.06	3.45
1995	38.04	3.31	56.81	3.39	76.90	3.45
2000	50.14	3.51	68.09	3.51	102.00	3.45
2010	58.46	3.74	81.71	3.72	122.91	3.64
2020	69.19	4.26	97.60	4.21	146.98	4.07
			NORTHWEST			
1980	21.80	1.99	23.18	1.99	25.04	2.00
1985	37.21	2.05	42.09	2.05	48.49	2.08
1990	37.90	2.98	47.18	3.36	55.71	2.99
1995	37.69	3.33	56.47	3.27	76.55	3.16
2000	49.66	3.52	67.68	3.39	101.52	3.16
2010	57.91	3.75	81.23	3.59	122.36	3.34
2020	68.57	4.27	96.98	4.06	146.29	3.73

TABLE B-27 (Cont'd)

EIA REGIONAL PROJECTIONS
INPUT TO COST CALCULATION
PROCEDURE
(1980 \$s)

Scenario

Year	Low-Range		Mid-Range		High-Range	
	Residual Oil (\$/BBL)	Industrial Coal (\$/MMBTU)	Residual Oil (\$/BBL)	Industrial Coal (\$/MMBTU)	Residual Oil (\$/BBL)	Industrial Coal (\$/MMBTU)
	NATIONAL AVERAGE					
1980	23.45	1.76	25.04	1.77	26.89	1.78
1985	39.34	2.49	44.78	2.54	51.38	2.57
1990	38.72	2.79	49.66	2.88	58.12	2.91
1995	39.69	2.90	51.58	2.98	62.66	3.05
2000	52.27	3.07	61.83	3.09	83.22	3.05
2010	61.01	3.27	74.21	3.26	100.28	3.23
2020	72.22	3.72	88.59	3.70	119.95	3.60

APPENDIX C

PROGRAM DESCRIPTION AND SOURCE CODE LISTING

The actual computation of the annuitized fuel cost differentials, or deltas, has been programmed in the FORTRAN language for implementation on a computer. A copy of the source listing for this program and a typical input data file are included in this Appendix. An overview of the data inputs, data outputs and program logic are provided in the following paragraphs.

The input data required consist of two lines of report heading, the beginning and ending years of the study (a span of no more than 40 years is permitted), a discount rate of utilities, a discount rate for industrials and the fuel types of alternate and current fuels; coal and oil in this case. Following this information are the data sets. A data set consists of a pair of price series data between which the annuity will be calculated. Two header records are needed within the data set to identify to which fuel the subsequent prices apply and various price extrapolation criteria, as well as the units of the input data and output data. Presently, the options for these fields are:

FUEL TYPE		UNITS	INPUT DATA OPTION
1	Coal	1 \$/BBL	1 A price for each year in the study.
2	Oil	2 \$/BOE*	2 Prices for selected years in the study (a linear interpolation between entries will be done).
		3 \$/MMBTU	3 A base year and price and ending year with price (also interpolated).
		4 \$/TON	4 A base year and price and a compound growth rate.
EXTRAPOLATION OPTION			
1	Repeat last non-zero price entry.		
2	Extrapolate at a linear rate determined by growth rate shown between the last two non-zero price entries.		

An END card signifies the end of data for the program run. Up to 10 data sets may be evaluated in a single run.

All fuel prices are converted to prices per barrel of oil equivalent and the annuities calculated for the two discount rates. The function ANUITY performs the calculation:

$$\Delta = PA \left[\frac{\sum_{i=1}^n fA(i) (1+k)^{-i}}{n} \right] - 1 - PB \left[\frac{\sum_{i=1}^n fB(i) (1+k)^{-i}}{n} \right] - 1$$

*: Barrel of Oil Equivalent

```

=====
THIS PROGRAM SHALL COMPUTE ANNUITIZED FUEL COST
DIFFERENTIALS. FOR A SINGLE PRODUCTION RUN THERE
MAY BE ONLY TWO FUEL TYPES- THE CURRENT FUEL TYPE
AND THE ALTERNATE FUEL TYPE. AT PRESENT ONLY THE
FUELS OIL AND COAL ARE SUPPORTED.
=====

```

```

PROGRAM ANUTY(INPUT,OUTPUT,TAPE11)

```

```

COMMON/DTA/ALT,CUR,COAL,OIL,BRLBTU,UNITS(4)

```

```

DIMENSION P(2,45,10),PUNITS(2,10),DR(2),FUEL(4),ANTY(2,10)
DIMENSION LIHDR(8),L2HDR(8)

```

```

INTEGER ALT,CUR,COAL,OIL,UNITS
INTEGER FTYPE,UNITIN,UNITOT,OPTION,PUNITS,FUEL

```

```

DATA MFLAG/0/,NSET/1/,COAL/1/,OIL/2/
DATA P/900*0./,BRLBTU/6.287/

```

```

DATA LIHDR/10*1H ,10*1H ,10*1H ,10*1H ,10*1H ,10*1H ,
110*1H ,10*1H /
DATA L2HDR/10*1H ,10*1H ,10*1H ,10*1H ,10*1H ,10*1H ,
110*1H ,10*1H /

```

```

- - - - - BEGINNING OF MAIN PROGRAM - - - - -

```

```

READ IN TWO LINES OF REPORT HEADER DATA AND PRINT SAME.

```

```

READ (11,5) (LIHDR(I), I=1,8), (L2HDR(N), N=1,8)
FORMAT(8A10,/,8A10)

```

```

PRINT 7,(LIHDR(I), I=1,8), (L2HDR(N), N=1,8)
FORMAT(/,/,/,20X,8A10,/,20X,8A10,/,/,/)

```

```

READ IN THE BASE YEAR AND THE ENDING YEAR.

```

```

READ(11,10) IYSTRT,IYEND
FORMAT(I4,1X,I4)
PRINT 10,IYSTRT,IYEND

```

```

COMPUTE THE TOTAL YEAR RANGE OF THE STUDY. THE STUDY SHALL
BE LIMITED TO 40 YEARS.

```

```

NYEARS=IYEND-IYSTRT
IF(NYEARS .LE. 40) GO TO 12
PRINT 11,NYEARS

```

```

11 FORMAT(10X,*** ATTEMPT TO PROJECT FOR *,13,* YEARS *,
1*MAXIMUM IS 40 YEARS ***,)
STOP

```

```

C
C READ IN THE UTILITIES DISCOUNT RATE AND THE INDUSTRIAL
C DISCOUNT RATE.
12 READ(11,15) DR(1),DR(2)
15 FORMAT(4X,F8.3,4X,F8.3)
C PRINT 15,DR(1),DR(2)
C
C INPUT THE ALTERNATE AND CURRENT FUEL TYPES.
C
C READ(11,20) ALT,CUR
20 FORMAT(18,2X,18)
C PRINT 20,ALT,CUR
C FUEL(ALT)=1
C FUEL(CUR)=2
C
C INPUT ALL THE COMMODITY DATA.
C
C READ(11,30) LEND,FTYPE,UNITIN,UNITOT,OPTION,NUMENT,
25 IMEXTRP,GRATE
30 FORMAT(A3,18,2X,18,2X,18,2X,11,2X,12,2X,11,2X,F8.3)
C PRINT 30,LEND,FTYPE,UNITIN,UNITOT,OPTION,NUMENT,
C IMEXTRP,GRATE
C IF(LEND .EQ. 3)END) GO TO 100
C
C IF THE FUEL TYPE IS NOT VALID, THEN STOP THE RUN.
C
C IF(FTYPE .EQ. ALT .OR. FTYPE .EQ. CUR) GO TO 32
C PRINT 31,FTYPE,NSET
31 FORMAT(10X,*** FUEL TYPE *,12,* OF DATA SET *,12,
1* IS NEITHER THE ALTERNATE OR CURRENT FUEL TYPE ***)
C STOP
C
C READ IN A YEAR AND PRICE (IN DOLLARS), ONE PAIR ON A LINE.
C
C DO 40 I=1,NUMENT
32 READ(11,35) IYEAR,PRICE
35 FORMAT(14,1X,F10.3)
C PRINT 35,IYEAR,PRICE
C
C IF THE YEAR IS NOT WITHIN THE RANGE OF THE STUDY, HALT THE RUN.
C
C IF(IYEAR .GE. IYSTRT .OR. IYEAR .LE. IYEND) GO TO 37
C PRINT 36,I,IYEAR,NSET
36 FORMAT(10X,*** A YEAR VALUE OF *,15,
1 * IS OUT OF RANGE FOR ENTRY *,12,
2 * OF DATA SET *,12,* ***)
C STOP
37 P(FUEL(FTYPE),IYEAR-IYSTRT+1,NSET)=PRICE
40 CONTINUE

```



```

C
C IF THE INPUT AND OUTPUT UNITS FOR THIS SET OF VALUES ARE
C NOT THE SAME, CONVERT THE INPUT DATA THE THE UNITS OF THE
C DESIRED OUTPUT.
C
C IF(UNITIN .NE. UNITOT) CALL CONVRT
C PUNITS(FUEL(FTYPE),NSET)=UNITOT
C
C IF ONLY THE BASE YEAR PRICE AND A GROWTH RATE ARE GIVEN, THEN
C FILL IN THE REMAINING YEARS.
C
C IF(OPTION .NE. 4) GO TO 45
C CALL GRORAT(P,FUEL(FTYPE),NYEARS,NSET,GRATE)
C GO TO 50
C
C INTERPOLATE THE PRICE DATA IF NECESSARY.
C
C 45 IF(OPTION .EQ. 2 .OR. OPTION .EQ. 3) CALL INTRPL(P,
C FUEL(FTYPE),NYEARS,NSET)
C
C DO PRICE DATA EXTRAPOLATION IF REQUIRED.
C
C IF(MEXTRP .NE. 0) CALL EXTRAP(P,FUEL(FTYPE),NYEARS,NSET,MEXTRP)
C
C THE DATA SETS ARE GROUPED IN PAIRS.
C
C 50 MFLAG=MFLAG+1
C IF(MFLAG .LT. 2) GO TO 25
C MFLAG=0
C NSET=NSET+1
C
C THERE MAY BE UP TO 10 SETS OF DATA.
C
C IF(NSET .LE. 10) GO TO 25
C
C GRAPH THE DATA SETS.
C
C 100 NSET=NSET-1
C CALL PRDTA(P,NYEARS,NSET,IYSTRT)
C
C CONVERT ALL UNITS TO BARREL OF OIL EQUIVALENTS BEFORE
C COMPUTING THE ANNUITIES.
C
C DO 60 N=1,NSET
C CALL CNVRT(P,ALT,FUEL(ALT),NYEARS,N,PUNITS(FUEL(ALT),
C N),UNITOT,P)
C PUNITS(FUEL(ALT),N)=UNITOT
C CALL CNVRT(P,CUR,FUEL(CUR),NYEARS,N,PUNITS(FUEL(CUR),
C N),UNITOT,P)
C PUNITS(CUR,N)=UNITOT
C 60 CONTINUE
C

```

C PRINT THE DATA TO BE USED IN THE ANNUITY CALCULATION.

C CALL PRDTA(P,NYEARS,NSET,IYSTRT)

C CALCULATE THE ANNUITY VALUES FOR CORRESPONDING DATA SET
C ENTRIES FOR THE TWO DISCOUNT RATES.

C DO 130 J=1,2

C DO 120 I=1,NSET

C ANTY(J,I)=ANUITY(P,NYEARS,I,DR(J))

120

C CONTINUE

C PRINT THESE ANNUITIES AND CORRESPONDING DISCOUNT RATE.

C CALL PRTANN(ANTY,J,NSET,DR(J))

130

C CONTINUE

C STOP

C END

C - - - - - END OF MAIN PROGRAM - - - - -

C *****
C *****

C SUBROUTINE INTRPL(P,AB,N,NSET)

C THIS ROUTINE WILL INTERPOLATE AT A LINEAR RATE
C BETWEEN TWO NON-ZERO ENTRIES IN A PRICE LIST
C FILLING IN ALL THE ZERO VALUED SLOTS.

C *****
C *****

INTEGER AB

$$\begin{aligned}NM &= N + 1 \\NN &= 0\end{aligned}$$

CONTINUE

```
IF(AB .EQ. 1) PRINT 15,NSET
```

```
IF(AB .EQ. 2) PRINT 16, NSET
```

LOOK FOR A GROUP OF ZERO ENTRIES.

$$I = NM - NN$$

```
ISTR=1
```

NZEROS=0

```
DO 50 J=ISTRT,I
IF(P(AB,J,NSET) .NE. 0.) GO TO 50
```

DO 30 K=J, I

```
IF(P(AB,K,NSET) .NE. 0) GO TO 35
```

```

NZEROS=NZEROS+1

```

CONTINUE

$$DISP=(P(AB,K,NSET)-P(AB,J-1,NSET))/FLOAT(NZEROS+1)$$
$$KK = K - 1$$

D0 40 V=J, KK

$$P(AB, M, NSET) = P(AB, M-1, NSET) + DISP$$

CONTINUE

$$I\text{STRT} = KK + 1$$

GO	TO	25
----	----	----

CONTINUE

RETURN

C-7

C-7

```

*****
*****

```

```

SUBROUTINE EXTRAP(P,AB,N,NSET,METHOD)

```

```

    THIS ROUTINE SHALL EXTRAPOLATE THE INPUT DATA FROM
    THE LAST NON-ZERO PRICE ENTRY THROUGH THE ENDING
    YEAR OF THE STUDY. METHOD VALUE 1 MEANS REPEAT
    THE LAST NON-ZERO PRICE FOR ALL THE EXTRAPOLATED
    ITEMS WHILE A VALUE OF 2 MEANS USE A LINEAR RATE
    DERIVED FROM THE LAST TWO NON-ZERO ENTRIES.

```

```

*****
*****

```

```

    DIMENSION P(2,45,10)
    INTEGER AB

```

```

    LOOK FOR THE LAST NON-ZERO ENTRY TO DETERMINE WHERE
    TO BEGIN THE EXTRAPOLATION.

```

```

    IF(P(AB,N+1,NSET) .NE. 0.) RETURN
    NN=N+1

```

```

    DO 20 I=1,NN

```

```

    IF(P(AB,NN-I,NSET) .EQ. 0.) GO TO 20

```

```

    THE NONZERO ITEM HAS BEEN FOUND.

```

```

    M=NN-I

```

```

    RATE=(P(AB,M,NSET)-P(AB,M-1,NSET))/

```

```

1    P(AB,M-1,NSET)

```

```

    IF(METHOD .EQ. 1) RATE=0.

```

```

    MM=M+1

```

```

    FILL IN THE MISSING VALUES THROUGH THE ENDING YEAR.

```

```

        DO 10 K=MM,NN

```

```

        P(AB,K,NSET)=P(AB,K-1,NSET)*RATE+P(AB,K-1,NSET)

```

```

        CONTINUE

```

```

    RETURN

```

```

    CONTINUE

```

```

    NO VALID DATA WAS FOUND IN THE PRICE ARRAY.

```

```

    IF(AB .EQ. 1) PRINT 30,NSET

```

```

30    FORMAT(10X,*** PRICE DATA ALL ZEROES FOR ALTERNATE *,
1    *FUEL IN DATA SET *,I2,* (EXTRAPOLATION PROCEDURE) ***)

```

```

    IF(AB .EQ. 2) PRINT 40,NSET

```

```

40    FORMAT(10X,*** PRICE DATA ALL ZEROES FOR CURRENT *,
1    *FUEL IN DATA SET *,I2,* (EXTRAPOLATION PROCEDURE) ***)

```

```

    STOP

```

```

    END

```

```

*****
*****

```

```

SUBROUTINE CNVERT(P,FTYPE,N,NY,NS,IN,IOUT,Q)

```

```

    THIS SUBROUTINE SHALL CONVERT THE PRICE OF
    THE INPUT DATA FROM UNITS 'IN' TO DOLLARS PER
    BARREL OF OIL OR DOLLARS PER BARREL OF OIL
    EQUIVALENT AS APPROPRIATE.

```

```

*****
*****

```

```

COMMON/DIA/ALT,CUR,COAL,OIL,BRLBTU,UNITS(4)
INTEGER ALT,CUR,COAL,OIL,UNITS
INTEGER FTYPE
DIMENSION P(2,45,10),Q(2,45,10)

```

```

-----

```

```

FACTOR=1.0

```

```

IF(FTYPE .NE. 1) GO TO 10

```

```

COAL CONVERSIONS FOLLOW.

```

```

IF(IN .EQ. 3) FACTOR=BRLBTU
IF(IN .EQ. 4) FACTOR=22.5/BRLBTU
IOUT=2
GO TO 50

```

```

10 IF(FTYPE .NE. 2) GO TO 20

```

```

OIL CONVERSIONS FOLLOW.

```

```

IF(IN .EQ. 3) FACTOR=BRLBTU
IOUT=1
GO TO 50

```

```

FUEL TYPE IS INVALID FOR THIS STUDY.

```

```

20 PRINT 21,FTYPE
21 FORMAT(10X,*** INVALID FUEL TYPE OF *,I2,
1* FOUND IN CONVERSION PROCEDURE ***)
STOP

```

```

50 DO 60 I=1,NY
    Q(N,I,NS)=P(N,I,NS)*FACTOR
60 CONTINUE
RETURN
END

```


SUBROUTINE CONVRT

THIS ROUTINE SHALL CONVERT THE PRICE OF A COMMODITY
FROM ITS INPUT UNITS TO A DESIRED OUTPUT UNITS.
THIS CAPABILITY IS PROVIDED FOR THOSE CASES WHERE
IT MAY BE DESIRABLE TO PRINT OR GRAPH THE FUEL
PRICES IN UNITS OTHER THAN THOSE UNDER WHICH THEY
WERE INPUT. FOR EXAMPLE, COAL PRICES ENTERED IN
DOLLARS PER TON AND OIL PRICES ENTERED IN DOLLARS
PER BARREL MAY BOTH BE CONVERTED TO DOLLARS PER
MMBTU IN ORDER TO APPEAR ON COMMON GRAPHIC AXES.

RETURN
END

SUBROUTINE GRORAT(P,AB,N,NSET,G)

THIS PROCEDURE SHALL APPLY A FIXED COMPOUND ANNUAL
GROWTH RATE TO THE BASE YEAR PRICE TO CALCULATE
THE COST OF THE COMMODITY IN THE YEARS FROM THE
BASE YEAR THROUGH YEAR 'N'.

DIMENSION P(2,45,10)
INTEGER AB

NN=N+1

DO 10 I=2, NN

P(AB,I,NSET)=P(AB,I-1,NSET)*G+P(AB,I-1,NSET)

CONTINUE

RETURN

END

FUNCTION ANUITY(P,NY,NSET,DR)

THIS FUNCTION SHALL COMPUTE THE ANNUITIES BETWEEN
A PAIR OF FUEL PRICES. IT IS ASSUMED THAT THE
ALTERNATE AND CURRENT FUEL PRICES HAVE ALREADY
BEEN CONVERTED TO LIKE UNITS OF DOLLARS PER
BARREL OF OIL EQUIVALENT.

DIMENSION P(2,45,10)

PANUM=0.

PBNUM=0.

DENOM=0.

DO 50 I=1, NY

TEMP=(DR+1.)*(-1)

PANUM=(P(1,I+1,NSET)/P(1,I,NSET))*TEMP+PANUM

PBNUM=(P(2,I+1,NSET)/P(2,I,NSET))*TEMP+PBNUM

DENOM=TEMP+DENOM

CONTINUE

ANUITY=(P(1,1,NSET)*((PANUM/DENOM)-1.))-
P(2,1,NSET)*((PBNUM/DENOM)-1.)

RETURN

END

```

*****
*****

```

```

SUBROUTINE PRDTA(P,NY,NSETS,IYR)

```

```

    THIS CODE SHALL PRINT THE PRICE DATA PER
    YEAR FOR THE ALTERNATE AND CURRENT FUELS.

```

```

*****
*****

```

```

COMMON/DTA/ALT,CUR,COAL,OIL,BRLBTU,UNITS(4)
DIMENSION P(2,45,10)
INTEGER ALT,CUR,COAL,OIL,UNITS

```

```

-----

```

```

IF(ALT .EQ. 1) NAM1=6H COAL
IF(ALT .EQ. 2) NAM1=6H OIL
IF(CUR .EQ. 1) NAM2=6H COAL
IF(CUR .EQ. 2) NAM2=6H OIL

```

```

    DO 100 I=1,NSETS
    PRINT 10,NAM1,NAM2,NAM1,NAM2,NAM1,NAM2,NAM1,NAM2,NAM1,NAM2
    FORMAT(/,/ /,5(2X,*YEAR*,3X,A6,3X,A6,2X),/)
    PRINT 25,(IYR+M-1,P(1,M,1),P(2,M,1),IYR+M,
1      P(1,M+1,1),P(2,M+1,1),IYR+M+1,P(1,M+2,1),
2      P(2,M+2,1),IYR+M+2,P(1,M+3,1),P(2,M+3,1),
3      IYR+M+3,P(1,M+4,1),P(2,M+4,1), M=1,45,5)
    25  FORMAT(5(2X,I4,3X,F6.2,3X,F6.2,2X))
    100 CONTINUE

```

```

    RETURN
    END

```



```

*****
*****

```

```

SUBROUTINE PRTANN(ANN,J,NS,DR)

```

```

    THIS ROUTINE SHALL PRINT THE ANNUITY RATES COMPUTED
    FOR ALL THE DATA SETS.

```

```

*****
*****

```

```

COMMON/DTA/ALT,CUR,COAL,OIL
DIMENSION ANN(2,10)
INTEGER ALT,CUR,COAL,OIL

```

```

-----

IF(ALT .EQ. 1) NAM1=6H COAL
IF(ALT .EQ. 2) NAM1=6H OIL
IF(CUR .EQ. 1) NAM2=6H COAL
IF(CUR .EQ. 2) NAM2=6H OIL
PRINT 10,NAM2,NAM1,DR

```

```

10  FORMAT(/,/ ,/,/,5X,*CONVERSION TO *,A6,* FROM *,
1A6,* WITH A DISCOUNT RATE OF *,F8.3,
2* YIELDS THE FOLLOWING ANNUITIES*,/)

```

```

C      DO 20 N=1,NS
        PRINT 15,N,ANN(J,N)
15     FORMAT(10X,*DATA SET *,I2,* RESULTS IN AN ANNUITY OF *,
1       F8.3,* DOLLARS*)
20     CONTINUE
      RETURN
      END

```

The format and field definitions corresponding to the program data input file shown on pages C-16 and C-17 are as follows:

1. Report Header Record

<u>Field</u>	<u>FORTTRAN Format Code</u>	<u>Values</u>
Line 1	8A10	80 Alphanumeric characters
Line 2	8A10	80 Alphanumeric characters

2. Year Limits Record

<u>Field</u>	<u>FORTTRAN Format Code</u>	<u>Values</u>
Beginning Year of Study	I4	Any Value
1 space	1X	
Ending Year of Study	I4	Any Value (Ending Year-Beginning Year must be less than or equal to 40 years)

3. Discount Rate Record

<u>Field</u>	<u>FORTTRAN Format Code</u>	<u>Values</u>
4 spaces	4X	
Utilities Discount Rate	F8.3	$0 \leq DR < 1.$
4 spaces	4X	
Industrial Discount Rate	F8.3	$0 \leq DR < 1.$

4. Fuel Type Record

<u>Field</u>	<u>FORTTRAN Format Code</u>	<u>Values</u>
Alternate Fuel Type	I8	1,2
2 spaces	1X	
Current Fuel Type	I8	1,2

5. Data Control Record (One for each set of data records)

<u>Field</u>	<u>FORTTRAN Format Code</u>	<u>Values</u>
END of data signal	A3	'END' or 3 spaces
Fuel Type	I8	1,2
2 spaces	2X	
Input Units	I8	1,2,3,4
2 spaces	2X	
Output Units	I8	1,2,3,4
2 spaces	2X	
Input Data Option	I1	1,2,3,4
2 spaces	2X	
Number of Entries	I2	>0
2 spaces	2X	
Extrapolation Option	I1	1,2
2 spaces	2X	
Growth Rate	F8.3	Fixed compound annual growth rate. No checks made.

6. Data Record

<u>Field</u>	<u>FORTTRAN Format Code</u>	<u>Values</u>
Year	I4	Beginning year $\leq n \leq$ ending year of study
1 space	1X	
Price	F10.3	Positive values no greater than \$99,999.999

Record
No.

C
O
L

1. DRI RESIDUAL FUEL OIL AND NEW CONTRACT COAL PRICES
EXTRAP. METHODS 1,2,3 ALTERNATE 1, ALTERNATE 2 (12/6/80)
1980 2020
4. DRU= .029DRI= .077
5. 1 2
6. 1 3 3 2 7 0 0.0
7. 1980 1.50
1985 1.87
1990 2.03
1995 2.23
2000 2.35
2010 2.62
2020 2.92
2 1 1 2 7 0 0.00
1980 25.64
1985 30.16
1990 36.52
1995 44.22
2000 49.79
2010 63.12
2020 80.01
1 3 3 2 7 0 0.00
1980 1.50
1985 1.87
1990 2.03
1995 2.23
2000 2.35
2010 2.62
2020 2.92
2 1 1 2 7 0 0.00
1980 29.77
1985 35.02
1990 42.40
1995 51.34
2000 57.80
2010 73.27
2020 92.88
1 3 3 2 7 0 0.00
1980 1.50
1985 1.87
1990 2.03
1995 2.23
2000 2.35
2010 2.35
2020 2.35
2 1 1 2 7 0 0.00
1980 25.64
1985 30.16
1990 36.52
1995 44.22
2000 49.79
2010 49.79
2020 49.79

	1	3	3	2	7	0	0.00
1980	1.50						
1985	1.87						
1990	2.03						
1995	2.23						
2000	2.35						
2010	2.35						
2020	2.35						

	2	1	1	2	7	0	0.00
1980	29.77						
1985	35.02						
1990	42.40						
1995	51.34						
2000	57.80						
2010	57.80						
2020	57.80						

	1	3	3	2	7	0	0.00
1980	1.50						
1985	1.87						
1990	2.03						
1995	2.23						
2000	2.35						
2010	2.62						
2020	2.92						

	2	1	1	2	7	0	0.00
1980	25.64						
1985	30.16						
1990	36.52						
1995	44.22						
2000	49.79						
2010	49.79						
2020	49.79						

	1	3	3	2	7	0	0.00
1980	1.50						
1985	1.87						
1990	2.03						
1995	2.23						
2000	2.35						
2010	2.62						
2020	2.92						

	2	1	1	2	7	0	0.00
1980	29.77						
1985	35.02						
1990	42.40						
1995	51.34						
2000	57.80						
2010	57.80						
2020	57.80						

END

DRI RESIDUAL FUEL OIL AND NEW CONTRACT COAL PRICES
 EXTRAP. METHODS 1,2,3 ALTERNATE 1, ALTERNATE 2 (12/5/80)

YEAR	COAL	OIL	YEAR	COAL	OIL	YEAR	COAL	OIL	YEAR	COAL	OIL	YEAR	COAL	OIL
1980	1.50	25.64	1981	1.57	26.54	1982	1.55	27.45	1983	1.72	28.35	1984	1.80	29.26
1985	1.87	30.16	1986	1.90	31.43	1987	1.93	32.70	1988	1.97	33.98	1989	2.00	35.25
1990	2.03	36.52	1991	2.07	38.06	1992	2.11	39.60	1993	2.15	41.14	1994	2.19	42.68
1995	2.23	44.22	1996	2.25	45.33	1997	2.28	46.45	1998	2.30	47.56	1999	2.33	48.68
2000	2.35	49.79	2001	2.39	51.12	2002	2.40	52.45	2003	2.43	53.79	2004	2.46	55.12
2005	2.49	56.46	2006	2.51	57.79	2007	2.54	59.12	2008	2.57	60.45	2009	2.59	61.79
2010	2.62	63.12	2011	2.65	64.81	2012	2.68	66.50	2013	2.71	68.19	2014	2.74	69.88
2015	2.77	71.56	2016	2.80	73.25	2017	2.83	74.94	2018	2.86	76.63	2019	2.89	78.32
2020	2.92	80.01	2021	0.00	0.00	2022	0.00	0.00	2023	0.00	0.00	2024	0.00	0.00

YEAR	COAL	OIL	YEAR	COAL	OIL	YEAR	COAL	OIL	YEAR	COAL	OIL	YEAR	COAL	OIL
1980	1.50	29.77	1981	1.57	30.82	1982	1.55	31.87	1983	1.72	32.92	1984	1.80	33.97
1985	1.87	35.02	1986	1.90	36.50	1987	1.93	37.97	1988	1.97	39.45	1989	2.00	40.92
1990	2.03	42.40	1991	2.07	44.19	1992	2.11	45.98	1993	2.15	47.76	1994	2.19	49.55
1995	2.23	51.34	1996	2.25	52.63	1997	2.28	53.92	1998	2.30	55.22	1999	2.33	56.51
2000	2.35	57.80	2001	2.39	59.35	2002	2.40	60.89	2003	2.43	62.44	2004	2.46	63.99
2005	2.49	65.54	2006	2.51	67.08	2007	2.54	68.63	2008	2.57	70.18	2009	2.59	71.72
2010	2.62	73.27	2011	2.65	75.23	2012	2.68	77.19	2013	2.71	79.15	2014	2.74	81.11
2015	2.77	83.08	2016	2.80	85.04	2017	2.83	87.00	2018	2.86	88.96	2019	2.89	90.92
2020	2.92	92.88	2021	0.00	0.00	2022	0.00	0.00	2023	0.00	0.00	2024	0.00	0.00

YEAR	COAL	OIL	YEAR	COAL	OIL	YEAR	COAL	OIL	YEAR	COAL	OIL	YEAR	COAL	OIL
1980	1.50	25.64	1981	1.57	26.54	1982	1.55	27.45	1983	1.72	28.35	1984	1.80	29.26
1985	1.87	30.16	1986	1.90	31.43	1987	1.93	32.70	1988	1.97	33.98	1989	2.00	35.25
1990	2.03	36.52	1991	2.07	38.06	1992	2.11	39.60	1993	2.15	41.14	1994	2.19	42.68
1995	2.23	44.22	1996	2.25	45.33	1997	2.28	46.45	1998	2.30	47.56	1999	2.33	48.68
2000	2.35	49.79	2001	2.35	49.79	2002	2.35	49.79	2003	2.35	49.79	2004	2.35	49.79
2005	2.35	49.79	2006	2.35	49.79	2007	2.35	49.79	2008	2.35	49.79	2009	2.35	49.79
2010	2.35	49.79	2011	2.35	49.79	2012	2.35	49.79	2013	2.35	49.79	2014	2.35	49.79
2015	2.35	49.79	2016	2.35	49.79	2017	2.35	49.79	2018	2.35	49.79	2019	2.35	49.79
2020	2.35	49.79	2021	0.00	0.00	2022	0.00	0.00	2023	0.00	0.00	2024	0.00	0.00

YEAR	COAL	OIL	YEAR	COAL	OIL	YEAR	COAL	OIL	YEAR	COAL	OIL	YEAR	COAL	OIL
1980	1.50	29.77	1981	1.57	30.82	1982	1.55	31.87	1983	1.72	32.92	1984	1.80	33.97
1985	1.87	35.02	1986	1.90	36.50	1987	1.93	37.97	1988	1.97	39.45	1989	2.00	40.92
1990	2.03	42.40	1991	2.07	44.19	1992	2.11	45.98	1993	2.15	47.76	1994	2.19	49.55
1995	2.23	51.34	1996	2.25	52.63	1997	2.28	53.92	1998	2.30	55.22	1999	2.33	56.51
2000	2.35	57.80	2001	2.35	57.80	2002	2.35	57.80	2003	2.35	57.80	2004	2.35	57.80
2005	2.35	57.80	2006	2.35	57.80	2007	2.35	57.80	2008	2.35	57.80	2009	2.35	57.80
2010	2.35	57.80	2011	2.35	57.80	2012	2.35	57.80	2013	2.35	57.80	2014	2.35	57.80
2015	2.35	57.80	2016	2.35	57.80	2017	2.35	57.80	2018	2.35	57.80	2019	2.35	57.80
2020	2.35	57.80	2021	0.00	0.00	2022	0.00	0.00	2023	0.00	0.00	2024	0.00	0.00

YEAR	COAL	OIL	YEAR	COAL	OIL	YEAR	COAL	OIL	YEAR	COAL	OIL	YEAR	COAL	OIL
1980	1.50	25.64	1981	1.57	26.54	1982	1.55	27.45	1983	1.72	28.35	1984	1.80	29.26
1985	1.87	30.16	1986	1.90	31.43	1987	1.93	32.70	1988	1.97	33.98	1989	2.00	35.25
1990	2.03	36.52	1991	2.07	38.05	1992	2.11	39.60	1993	2.15	41.14	1994	2.19	42.58
1995	2.23	44.22	1996	2.25	45.33	1997	2.28	45.45	1998	2.30	47.56	1999	2.33	48.58
2000	2.35	49.79	2001	2.38	49.79	2002	2.40	49.79	2003	2.43	49.79	2004	2.46	49.79
2005	2.49	49.79	2006	2.51	49.79	2007	2.54	49.79	2008	2.57	49.79	2009	2.59	49.79
2010	2.62	49.79	2011	2.65	49.79	2012	2.68	49.79	2013	2.71	49.79	2014	2.74	49.79
2015	2.77	49.79	2016	2.80	49.79	2017	2.83	49.79	2018	2.85	49.79	2019	2.89	49.79
2020	2.92	49.79	2021	0.00	0.00	2022	0.00	0.00	2023	0.00	0.00	2024	0.00	0.00

YEAR	COAL	OIL	YEAR	COAL	OIL	YEAR	COAL	OIL	YEAR	COAL	OIL	YEAR	COAL	OIL
1980	1.50	29.77	1981	1.57	30.82	1982	1.55	31.87	1983	1.72	32.92	1984	1.80	33.97
1985	1.87	35.02	1986	1.90	36.50	1987	1.93	37.97	1988	1.97	39.45	1989	2.00	40.92
1990	2.03	42.40	1991	2.07	44.19	1992	2.11	45.98	1993	2.15	47.76	1994	2.19	49.55
1995	2.23	51.34	1996	2.25	52.63	1997	2.28	53.92	1998	2.30	55.22	1999	2.33	56.51
2000	2.35	57.80	2001	2.38	57.80	2002	2.40	57.80	2003	2.43	57.80	2004	2.46	57.80
2005	2.49	57.80	2006	2.51	57.80	2007	2.54	57.80	2008	2.57	57.80	2009	2.59	57.80
2010	2.62	57.80	2011	2.65	57.80	2012	2.68	57.80	2013	2.71	57.80	2014	2.74	57.80
2015	2.77	57.80	2016	2.80	57.80	2017	2.83	57.80	2018	2.85	57.80	2019	2.89	57.80
2020	2.92	57.80	2021	0.00	0.00	2022	0.00	0.00	2023	0.00	0.00	2024	0.00	0.00

CONVERSION TO OIL FROM COAL WITH A DISCOUNT RATE OF .029 YIELDS THE FOLLOWING ANNUITIES

DATA SET 1 RESULTS IN AN ANNUITY OF 16.247 DOLLARS
 DATA SET 2 RESULTS IN AN ANNUITY OF 19.553 DOLLARS
 DATA SET 3 RESULTS IN AN ANNUITY OF 11.920 DOLLARS
 DATA SET 4 RESULTS IN AN ANNUITY OF 14.442 DOLLARS
 DATA SET 5 RESULTS IN AN ANNUITY OF 11.361 DOLLARS
 DATA SET 6 RESULTS IN AN ANNUITY OF 13.882 DOLLARS

CONVERSION TO OIL FROM COAL WITH A DISCOUNT RATE OF .077 YIELDS THE FOLLOWING ANNUITIES

DATA SET 1 RESULTS IN AN ANNUITY OF 10.521 DOLLARS
 DATA SET 2 RESULTS IN AN ANNUITY OF 12.767 DOLLARS
 DATA SET 3 RESULTS IN AN ANNUITY OF 8.664 DOLLARS
 DATA SET 4 RESULTS IN AN ANNUITY OF 10.571 DOLLARS
 DATA SET 5 RESULTS IN AN ANNUITY OF 8.416 DOLLARS
 DATA SET 6 RESULTS IN AN ANNUITY OF 10.323 DOLLARS

APPENDIX D

ALTERNATE SOURCES OF OIL PRICE FORECASTS ONLY

In the course of identifying alternate sources of forecasts for this report, three studies were acquired which contained projections of world oil prices, but no corresponding projection of coal prices against which annuity computations could be made. Descriptions of these studies and their principal results are included in this appendix as supplemental trajectories to compare with the oil price forecasts contained in Section II.

The specific studies are:

- o OPEC Policies, Revenues, and World Energy Supplies, Feb., 1980, D.S. Hirshfeld, et.al., Virginia Polytechnic Institute and State University.
- o World Oil Graphics, Nov., 1980, E. Farrow, The Energy Modeling Forum; and
- o "Gains to Producers From the Cartelization of Exhaustible Resources," Robt. S. Pindyck, in the Review of Economics and Statistics, May, 1978, pps. 238-251

The highlights of each study are summarized in the following paragraphs.

Hirshfeld, et al.

This study was prepared under contract by Virginia Polytechnic Institute and State University for the U.S. State Department's Office of External Research, and the Departments of Energy and Commerce. The principal purpose of the study was to assess a range of possible oil price trajectories that OPEC may choose in terms of their effects on world economic activity, energy consumption, international trade balances, cash flows, and the accumulation of foreign exchange by OPEC members (and non-OPEC oil and gas exporters). To carry out the analysis, a model of

international energy markets, the Long Range Energy Development and Supplies (LORENDAS) model, was employed.

The oil price trajectories input to the model were predicated on a series of assumed real oil price growth rates from 1978 to 2000. The following table summarizes the specific rates, and a year 2020 price associated with each rate based on a 1978 crude oil price of \$15.13/BBL (1980 \$s).

Growth Rate	0	3.0%	4.5%	5.8%	7.5%
Year 2020 Price (based on a 1978 price of \$15.13/BBL in 1980 \$s)	\$15.13	\$52.36	\$96.10	\$161.52	\$315.50

The 0, 3, and 4.5% cases yield price paths well within EIA's updated high price trajectory. The remaining cases, however, yield substantially higher prices by 2020 than the EIA updated high price scenario.

EMF/World Oil Graphics

This EMF study was conducted for the purpose of comparing the world oil price forecasts of ten different models of world oil markets when common sets of assumptions and non-price variable values are utilized by each model, as far as possible. Twelve such sets of assumptions and underlying parameter values were defined as scenarios over which the models were simulated. A formal report describing in detail the methods, scenarios, model structures, and results of this study will be published by the EMF in Spring, 1981.

The document furnished by EMF for this report is a set of graphical displays of the oil price trajectories generated by the ten models for each of the twelve scenarios specified. Four of these scenarios have been selected for comparison in this appendix, and reflect the general range of forecast prices observed in all twelve scenarios.

The following table summarizes the approximate values of the highest and lowest price forecast for 2020, and the identifying scenario.

		<u>Scenario</u>			
<u>Forecast</u>		<u>Reference</u>	<u>Optim- istic</u>	<u>Low Elasticity</u>	<u>High Price</u>
2020 Price in 1980 \$s/BBL	Max	\$130.00	\$68.00	\$200.00+	\$175.00
	Min	\$ 60.00	\$40.00	\$ 50.00	\$ 60.00

The reference and optimistic cases fall generally in the range of EIA's updated oil price forecasts. The low elasticity case assumes that oil demand is price-inelastic through 2020, which tends to agree with the low system elasticity estimate discussed in section II.1. The highest forecast price trajectory in that EMF scenario passes through the \$200.00/BBL

limiting value on the graph by the year 2008.

As would be expected, the range of prices forecast by the models, although operating on the same sets of scenario assumptions, is substantial

Pindyck

The Pindyck paper was written in 1976, although not published until 1978. Hence, the absolute levels of the oil price trajectories contained therein are very much out of date.

Based on the assumption that OPEC members maximize the present value of net profits, he considers the consequences for the "optimal" price path in four cases corresponding to competitive and monopolistic market structures, and alternate producer discount rates of 5 percent and 10 percent.

The solution price trajectories exhibit compound growth rates ranging between 2.4% and 10% for a 25 to 30-year period beyond 1980. Rates in excess of 3% per year applied to the observed mid-1980 price of crude oil (the refiner requisition cost of crude cited in section II of this report) produce trajectories substantially above EIA's high price scenario by 2020.