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FINAL REPORT
AND
INITIAL UPDATE
OF THE
ENERGY ECONOMIC DATA BASE (EEDB) PROGRAM
PHASE I

PREPARED FOR

THE U.S. DEPARTMENT OF ENERGY
UNDER CONTRACT NUMBER EN-78-C-02-4954

VOLUME III OF III

BY

united engineers
& constructors inc.

DECEMBER 1979

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DECEMBER 1979

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APPENDIX D-2

PRACTICAL TARGET ECONOMICS FOR THE LIQUID METAL FAST BREEDER REACTOR NUCLEAR POWER GENERATING STATION

Note: The purpose of this paper is to develop the arguments necessary to support an assessment of the feasibility of a target economics approach to conceptual design and cost estimating of the LMFBFR nuclear power generating station.

D2.1 INTRODUCTION

Since the 1940's the Liquid Metal Fast Breeder Reactor (LMFBFR) has been recognized as being capable of providing a new and virtually inexhaustible energy resource. However, this resource cannot be commercially realized until clear evidence is provided that the LMFBFR is competitive with alternatives. Historically, it has been assumed that an LMFBFR Nuclear Power Generating Station (NPGS) will have a higher capital cost than a Light Water Reactor (LWR) Nuclear Power Generating Station. The expectation has been that these higher capital costs will be offset by lower fuel cycle costs which favor the LMFBFR as uranium prices rise. Fuel costs for non-breeders will rise through the use of limited resources and the increased recovery costs caused by depletion of economic sources of U_3O_8 . In other words, the LMFBFR reaches parity with competing energy alternatives when high fuel costs develop a fuel cycle cost differential in favor of the LMFBFR to the extent that its higher capital costs are offset.

Capital costs are relatively higher for the LMFBFR because more capital equipment is required than for competing alternatives. Most of the additional capital equipment is in the Reactor Plant and is related to circulating, handling, storing and containing the liquid metal, sodium. Specifically, capital costs are added by the need for intermediate sodium loops and heat exchangers and accommodation of the chemical characteristics and induced radioactivity of sodium. Costs are also added in the structures and electric plant in support of the additional reactor plant equipment.

Fuel cycle costs are expected to be lower for the LMFBR because the principal fissile material is plutonium, instead of U-235, the breeder is a net producer of plutonium after the initial core loading, and nuclear fuel cycle costs for the LWR are very sensitive to rises in the cost of uranium. In order to provide definition of the capital cost versus fuel cycle cost trade-off, LWR fuel cycle costs need to be related to target LMFBR capital costs. Breeding ratio, doubling time and burnup must also be considered. However, if the resulting LMFBR fuel cycle costs are sufficiently lower than the LWR fuel cycle costs, the higher LMFBR capital costs (minimized by target economics) may be offset.

Predictions for capital cost can introduce uncertainties if first-of-a-kind contingencies and penalties for Research and Development (R&D) are passed on to the nth-of-a-kind commercial design. Development of unit cost data can introduce uncertainties if a composite cost is developed over too wide a range of units or if a limited unit cost is applied indiscriminantly over a wide range of equipment or commodities. Inclusion of the time value of money can also introduce uncertainties, unless assumptions regarding fuel cycle elements, interest rates, fixed charges, capacity factors, start-up dates and other parameters are clearly stated and completely understood. For comparison purposes, target economics are best developed on the basis of constant dollars, controlled unit costs, no contingencies or R&D cost penalties and maximum unit size to take advantage of the economy of scale for nuclear units.

Uncertainties

The Clinch River experience and the Prototype Large Breeder Reactor (PLBR) Program produced cost estimates which give LMFBR to PWR capital cost ratios

that would require yellowcake (U_3O_8) prices to rise from the current \$40/pound range to the \$200/pound range for "breakeven" to be achieved. Uncertainties in accepting such a result are:

- a. LMFBR capital cost studies include large first-of-a-kind (FOAK) contingencies, as well as allowances for R&D that are not compatible with a mature, commercial design.
- b. Estimates of fuel cycle costs vary widely, depending on what assumptions are made regarding fuel cycle elements, fuel burnup, time value of money, capacity factors and other parameters.
- c. Projections for availability of yellowcake and its cost for dates beyond 1980 vary widely.

All three uncertainties are mutually interactive, providing a wide variety of results that depend upon the assumptions made. Interpretation of one conclusion relative to another is dependent on an understanding of the multiplicity of complex interactions that are related to varying sets of assumptions.

Target Economics

An alternative to uncertainty is to reverse the situation by making a few acceptable assumptions relative to "target" designs, determining the resulting "target" costs necessary to be met and then evaluating the potential for the LMFBR to meet the target. Questions needing answers are:

- a. Is it possible to produce a competitive LMFBR nuclear power generating station?
- b. What must be done to accomplish this?
- c. If it cannot be done, what prevents the target economics from being met?

Fuel Cost Assumptions and Related Targets

Yellowcake is currently selling in the range of \$40/pound. It is reasonable to assume that at some point prior to the year 2000, yellowcake will rise to the range of \$80/pound in 1978 constant dollars. This is equivalent to an increase in real value of about three percent per year. Such a doubling of price will occur for a variety of reasons such as; market influence of rising coal costs; declining availability of lower cost ores; declining economic incentives to expand the supply; and rising demand. Although there is little doubt that yellowcake costs will double, it is uncertain when they will double. For the purposes of this discussion, it is assumed that such an event has a high probability of occurrence by the year 2000.

Studies indicate various impacts of the cost of yellowcake on the allowable breakeven differential between LMFBR NPGS and LWR NPGS capital costs. The range rises from a conservative estimate of approximately \$135/kW to as much as \$550/kW. In determining the target economic factors, the most conservative number should be used. Consequently, for a basic assumption for a projected commercialization date of 2000, and a doubling of yellowcake price by the year 2000, an LMFBR NPGS capital cost should not exceed the capital cost of a PWR NPGS by more than approximately \$135/kW.

Capital Cost Assumptions

In order to test the validity of the target economic approach, comparison was made between a 3800 MWt PWR, single unit, nuclear power generating station, having a net electrical output (at the generator step-up transformer terminals) of 1270 MWe and a 3800 MWt LMFBR, single unit, nuclear power generating station, having a net electrical output of 1390 MWe. It is evident that

economy of scale plays an important part in the impact of this comparison. Therefore, the largest legally licensable size unit (3800 MWt) is chosen to determine the target economics.

The cost information for the PWR NPGS is based upon the NUREG PWR Base Data Study given in Table 1-3, which in turn is based upon actual United Engineers & Constructors Inc. (UE&C) design projects and previous cost estimates. The cost information for the LMFBR NPGS is based upon an early UE&C cost study modified by recent cost study experience and results of the Phase II, Prototype Large Breeder Reactor Study (PLBR) contractor team cost data given in the LMFBR Base Data Study listed in Table 1-3. Base costs (Direct plus Indirect Costs only) are based on January 1, 1978 constant dollars, with no allowances for Contingency, Escalation, or Allowance for Funds Used During Construction (AFUDC). In addition, no contingencies for uncertainties or penalties for R&D costs have been assigned to the LMFBR, in order to develop target economics for a commercially competitive plant.

LMFBR Reactor Plant Cost Assumptions

The major differences in capital cost between the LMFBR and the PWR occurs in the Reactor Plant Account. For the purposes of defining a first cut at realistic Reactor Plant Costs, the Phase II PLBR Program Reactor Plant Cost Estimates that were reported by the three Contractor Teams are used as a base. Sub-account 222, "Heat Transport System" (HTS) is determined to include about 60 percent of the Reactor Plant Account dollars. Therefore, this account is investigated from the standpoint of establishing practicable cost targets for a commercialized LMFBR Power Plant.

Generally, target costs for major HTS components, such as the steam generator, intermediate heat exchanger and sodium pumps, may be optimistically selected because:

- a. the LMFBR has a wider base from which to transfer technology than did the PWR at a similar stage of development;
- b. manufacturing techniques, such as welding and fabrication, are more mature and sophisticated than during development of the PWR;
- c. ultimate heat sink systems are simpler for the LMFBR than for the PWR.

Steam Generators (SG) for the LMFBR are assumed to be non-safety related, having a cost per square foot of heat transfer surface equal to that of the PWR steam generators. This assumption is founded upon the design basis that the secondary loops have no decay heat removal function. Consequently, the secondary loops may be non-Seismic Category I, and non-safety related downstream of the isolation valves at the containment piping penetrations. Elimination of safety-related requirements significantly reduces the uncertainties of regulatory escalation and obsolescence and of codes and standards proliferation. Under these circumstances, steam generators may have single wall tubes, if tube design and leak detection techniques can keep risk of loss from sodium-steam reactions acceptably low. Non-safety related, non-Seismic Category I, single wall tube, LMFBR SG costs will approach PWR SG costs as a target when major ancillary components of PWR systems (e.g., pressurizers), which are required to effectively utilize heat transfer surface, are included in the PWR SG cost.

Intermediate Heat Exchangers (IHX) for the LMFBR are assumed to be designed to Seismic Category I, Safety Class requirements, having a cost per square foot of heat transfer surface equal to 1.5 times that of the PWR SG. While the IHX utilizes a less mature technology and is not as well proved as the

PWR SG, pressures are significantly lower and heat transfer coefficients are greater, resulting in less surface area per kW than for the PWR SG. Therefore, it is believed that this factor represents a reasonable degree of conservatism for this component, relative to a mature, PWR plant.

Sodium Pumps for the LMFBR are assumed to be custom built pumps having a cost per horsepower of 1.25 times that of PWR custom built reactor circulating pumps. This factor represents the current level of uncertainty for these components and includes allowance for the necessary variable speed drives for flow control.

Reactor Plant Account installed costs, after modification of the heat transport system in accordance with the above stated assumptions, are reduced by approximately 60 percent of the values reported by the PLBR contractors. No cost changes are made in the 40 percent of the Reactor Plant Account not included in Sub-account 222, "Heat Transport Systems". The modified PLBR Reactor Plant costs fall into a range between $\$315 \times 10^6$ and $\$340 \times 10^6$. The midpoint of this range, rounded off, is taken as the Reactor Plant Account Cost and amounts to $\$330 \times 10^6$. Component cost targets are as given in the following table:

LMFBR Component Cost Targets

<u>Component</u>	<u>Cost Target</u>	<u>Unit Cost</u>
Steam Generator	1.0 x PWR	\$/ft ² heat transfer surface
Intermediate HX	1.5 x PWR	\$/ft ² heat transfer surface
Sodium Pumps	1.25 x PWR	\$/horsepower

LMFBR Turbine Plant Cost Assumptions

The turbine plant account for the LMFBR target is based upon the turbine plant account for the NUREG HS12 Base Data Study given in Table 1-3. Adjustments were made for escalation, size, cycle temperature and pressure and turbine rated pressure; provisions for steam reheat are added. After all adjustments are made, the LMFBR Turbine Plant Account amounts to $\$121 \times 10^6$.

LMFBR Structures and Improvements Cost Assumptions

The structures account for the LMFBR NPGS is based upon the structures accounts for the NUREG PWR Base Data Study and the early UE&C LMFBR cost study. Suitable adjustments are made for plant size and escalation. Values for the various sub-accounts of the LMFBR nuclear power generating station are derived from assumptions based upon engineering judgment and experience.

Cost for the Site Improvements and the Control, Auxiliaries and Diesel Generator Building sub-accounts of the 3800 MWt LMFBR NPGS are assumed to be the same as for the 3800 MWt PWR NPGS. Costs for the Reactor Service Building and Miscellaneous Building sub-accounts are taken from the adjusted costs of the early UE&C LMFBR cost study, because distribution of elements in these sub-accounts were considerably different from those in the corresponding 3800 MWt PWR NPGS sub-accounts.

Cost for the Containment Building sub-account of the 3800 MWt LMFBR NPGS is assumed to be the same as for the 3800 MWt PWR NPGS. Typically, an LMFBR containment has a larger diameter than an equivalent thermal rating PWR, primarily because of the space required to enclose the large expansion loops in the primary sodium piping. For the purposes of developing optimum target costs, the assumption is made that acceptable compliant members (bellows)

are available and utilized for the year 2000 commercial plant. Therefore, it is assumed that the containment could be reduced in diameter to that of an equivalent thermal rating PWR, as a minimum, through use of compliant parts and components.

Cost of the Steam Generator Building subaccount taken from the adjusted costs of the early UE&C LMFBR study is for a three loop plant, while the current study is for a four loop plant. However, as discussed above, under LMFBR Reactor Plant Cost Assumptions, the steam generators are assumed to be non-Seismic Category I. Consequently, the steam generator buildings need not be Seismic Category I design. In addition, the steam generators of the four loop plant will be somewhat smaller than those of the three loop plant. Therefore, it is assumed that the cost reduction from deletion of Seismic Category I design and the smaller size of the steam generators offset the cost increase from adding a fourth steam generator building.

Cost of the Turbine Building subaccount is taken from the adjusted costs of the early UE&C LMFBR cost study. This value is compared with the 3800 MWt PWR NPGS Turbine Building and the HS12 (1232 MWe) Turbine Building costs and found to be reasonable, even though it is based on twin turbines (two @ 750 MWe). The cost is lower than for the PWR turbine building, because the turbine is shorter and the condensers are smaller. The cost is slightly higher than for the fossil turbine building, because of the addition of steam reheaters.

After making these assumptions and adjustments, the LMFBR Structures and Improvements Account amounts to $\$128 \times 10^6$.

Other LMFBR Plant Cost Assumptions

The electric plant, miscellaneous plant, main condenser heat rejection system and special materials accounts are taken from the adjusted costs of the early UE&C LMFBR study. The values of these accounts are compared with the values in the same PWR accounts and found to have a reasonable correlation.

For example, it is expected that the electric plant account would be considerably higher for the LMFBR than the PWR, because the LMFBR has twice as many large circulator drives. The drives are variable speed and require expensive speed control equipment and the LMFBR requires a substantial quantity of electric heat tracing to control sodium temperatures during short shutdowns and at plant start-up. These LMFBR accounts amount to $\$90 \times 10^6$.

The costs developed in this comparison are based on using current codes and standards, applicable regulatory guides and other requirements in accordance with 10CFR50, USDOE-RDT standards requirements are not included in these costs.

LMFBR Indirect Costs Assumptions

Indirect Costs for the LMFBR are based on the 3800 MWe PWR NPGS indirect costs, because the LMFBR indirect costs are an area of general uncertainty and disagreement. The PWR indirect costs are adjusted by two factors to give conservative values for LMFBR indirect costs. The first factor is the LMFBR/PWR ratio of electrical kilowatts to account for additional engineering and construction services associated with the higher LMFBR net output. The second factor is taken as 1.25 to establish the level of additional engineering and construction services related to the LMFBR target economics. These adjustments give Indirect Costs for the LMFBR that amount to $\$278 \times 10^6$.

LMFBR/PWR Capital Cost Comparison

Table D2-1 presents the Direct and Indirect capital costs for a 3800 MWt, 1390 MWe LMFBR, Single Unit, Nuclear Power Generating Station. These costs are derived in accordance with the discussion presented above.

- a. Total capital costs are: LMFBR $\$949 \times 10^6$; PWR $\$691 \times 10^6$
- b. Total $\$/kW$ are: LMFBR 683; PWR 544
- c. LMFBR/LWR $\$/kW$ Ratio is 1.25
- d. The delta $\$/kW$ is 138

Various observations may be made concerning the degree of confidence in the LMFBR capital cost numbers. First, all of the direct cost accounts except for the Reactor Plant Account may be expected to have a relative degree of confidence that is similar to that held for the corresponding PWR accounts. The degree of confidence for the Reactor Plant Account is estimated to be 20 percent lower than for the PWR Reactor Plant Account. The degree of confidence for the Indirect Costs is estimated to be 10 percent lower than for the PWR Indirect Costs.

Using these assessments of the confidence of the estimate, the $\$/kW$ for the LMFBR may be expected to vary within the range of 544 to 822. The corresponding range of LMFBR/PWR $\$/kW$ ratios is 1.0 to 1.5. The delta $\$/kW$ then varies within the range of 0 to 278. It is unlikely that the lower point in any of these ranges will be approached.

Conclusions

Target economics are developed for a year 2000 commercial LMFBR, single unit, nuclear power generating station. Assuming that a doubling of yellowcake price from \$40 to \$80 per pound occurs by the year 2000 and that this is conservatively equivalent to a delta $\$/kW$ between LMFBR and LWR of 135, it

may be concluded that the commodity and system cost targets developed represent parity between LMFBR and PWR. If yellowcake costs rise higher than assumed, which is likely, and if the delta \$/kW represented by the breakeven ore cost is higher than estimated, which also is likely, then, all other things being equal, the LMFBR will be at least competitive with the PWR.

If the capital cost estimate is in error to the extent that the delta \$/kW is at the upper end of the confidence range, the corresponding conservative ore cost is \$200 per pound of yellowcake. Whether or not these cost targets can be met in practice depends upon the willingness of users, regulators, managers, engineers, lawyers and public interest groups to focus on the real issues of long term energy needs, as they are related to the risks, benefits and costs of the LMFBR. Realistic target costs have been set. What is now required, is a concerted effort to refine those target costs and then to determine exactly how such targets can be met.

Such an effort was undertaken in the Energy Economic Data Base (EEDB) Phase I. A detailed conceptual technical design and capital cost estimate was prepared, based on the target economic philosophy of reducing design requirements to a minimum practicable level in order to establish a lowest possible cost. The Nuclear Steam Supply System design was prepared by Combustion Engineering, Inc. Balance of Plant design was prepared by UE&C. Overall management of the Target Economic Approach is by UE&C with oversight by the U.S. Department of Energy.

TABLE D2-1

ENERGY ECONOMIC DATA BASE

LMFBR CAPITAL COSTS WITH PWR CAPITAL COST COMPARISON
 BY THE TARGET ECONOMIC APPROACH
 (1/1/78 - \$10⁶)

Account No.	Description	LMFBR 3800 MWt @ 1390 MWe	PWR 3800 MWt @ 1270 MWe
20	Land and Land Rights	2.2	2.2
21	Structures and Improvements	128.2	117.7
22	Reactor Plant Equipment	330.0	153.0
23	Turbine Plant Equipment	121.1	130.6
24	Electric Plant Equipment	51.8	44.8
25	Miscellaneous Plant Equipment	12.6	14.2
26	Main Condenser Heat Rejection System	22.3	25.9
27	Special Materials	3.2	0.0
<u>Total Direct Cost</u>		<u>671.4</u>	<u>488.4</u>
91	Construction Services	110.7	80.9
92	Home Office Engineering and Service	121.4	88.7
93	Field Office Engineering and Service	<u>45.4</u>	<u>33.2</u>
<u>Total Indirect Cost</u>		<u>277.5</u>	<u>202.8</u>
<u>TOTAL COST</u>		<u>948.9</u>	<u>691.2</u>
<u>Total \$/kW</u>		682.7	544.3
<u>LMFBR \$/kW Ratio</u> PWR		1.25	*

@ Largest licensable plant

* Not Applicable

APPENDIX D-3

APPENDIX D-3

AIR QUALITY IMPACT ANALYSIS FOR DETERMINATION OF THE ACCEPTABILITY OF QUALIFIED HIGH AND LOW SULFUR COAL-FIRED FACILITY DESIGNS FOR THE HYPOTHETICAL MIDDLETOWN SITE

D3.1 INTRODUCTION

An air quality impact study has been performed to estimate the acceptability, from a licensing standpoint, of the four qualified coal-fired plant designs contained in the Energy Economic Data Base, Phase I (refer to Table 1-2). Each of the four plant designs are environmentally qualified by virtue of the incorporation of design features necessary to meet plant emission requirements current as of January, 1978. The hypothetical Middletown site (refer to Appendix A2), on which each plant is located, is an average continental location in the northeastern United States. This study is intended as a general guidance tool and is not necessarily applicable to all possible plant configurations and plant site regions. Low background pollution levels and flat terrain were assumed in order to simplify the analysis. The modeling was performed using versions of Environmental Protection Agency (EPA) models current as of January, 1978. The four plants analyzed were 800 MWe and 1200 MWe high and low sulfur coal-fired facilities. The plant designs are in conformance with the New Source Performance Standards (NSPS) in effect in January, 1978. The NSPS control sulfur dioxide (SO_2), oxides of nitrogen (NO_x), and total suspended particulates (TSP) emissions.

Impacts of SO_2 , NO_x , and TSP are evaluated with accepted atmospheric dispersion models for each of the plant types. The impacts are then combined with representative ambient background levels and compared to primary National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD), Class II increments. Then, each plant's acceptability is subjectively evaluated with respect to the probability that attainment of

individual NAAQS and PSD increments could be demonstrated after a final complete air quality monitoring and impact modeling analysis is performed.

D3.2 METHODOLOGY

D3.2.1 Site Characteristics

Certain assumptions are made concerning the site region in order to simplify this analysis. First, the site terrain is assumed to be flat, so that no indirect or direct effects on the plume by terrain (such as aerodynamic downwash and plume centerline impaction) need to be accounted for. Second, the site is assumed to be located in a rural area which is not industrialized, and has no other major pollutant sources present, such that ambient background levels are low. For this study, the background levels are presumed to be 20 percent of the NAAQS, permitting the assumption that the site is located in an "attainment" air quality region (i.e. region in which a given air quality standard is met). It is also assumed that the full PSD increment is available in the region.

D3.2.2 Air Quality Models

Three EPA air quality dispersion models were utilized in this air quality study: PTMAX¹, PTMTP¹, and CRSTER². Although each model has a different level of sophistication, all three models are based upon straight-line, steady-state Gaussian plume distribution assumptions which describe the plume dispersion from a point source.

The models PTMAX and PTMTP are "screening" models which are used to identify hypothetical worst case source impacts. PTMAX predicts the magnitude and distance of maximum ground-level concentrations for a pre-selected range of possible meteorological conditions. Once the approximate distance to the

maximum concentration and the meteorological condition producing the maximum concentration is known, the somewhat more sophisticated PTMTP can be utilized. The PTMTP model provides the added ability to analyze the plume "trapping" condition in which upward mixing of the plume is inhibited by a low atmospheric mixing height, or "lid". As a result, the ground-level concentrations can markedly increase.

The third, and most refined model employed, was CRSTER which utilizes actual observed hourly meteorological data to estimate concentrations for 1-hour, 3-hour, 24-hour and annual averaged time periods. Concentrations are computed for a series of concentric circular arrays of receptor locations, each of which is centered on the source. The model estimates concentrations for each hour based upon hourly wind direction, wind speed, Pasquill stability class and mixing height data. Therefore, the average concentrations are calculated by CRSTER, unlike the screening methods, on the basis of measured meteorology rather than hypothesized worst case conditions.

In addition to the above model analyses, a special transient meteorological condition was evaluated. This condition is that in which a morning temperature inversion is dissipated by insolation, potentially resulting in "fumigation" of the plume at a particular receptor. These calculations were performed according to an EPA³ recommended method.

D3.2.3 Meteorological Data

Meteorological data were selected to approximate the climate of Middletown, U.S.A. National Weather Service hourly observations from Logan Airport (Boston, Massachusetts) for the year 1964 were adopted. Even though Logan Airport

is a coastal location, these data are still considered representative of the aspects of Middletown's climatology which affect plume dispersion. The mixing height data were derived from daily morning upper air soundings taken at Portland, Maine, located about 90 miles northeast of Logan Airport; it is the nearest station to Logan recording such data.

D3.2.4 Source Data

Emission rates and stack parameters for each plant are presented in Table D3 - 1. These data were based on the plant model information given in Table 4-2; this table includes the Eastern and Western coal compositions, which were assumed for the high and low sulfur plants, respectively. For the high sulfur coal plants, the effluent from combustion of the 3.61 percent sulfur coal was assumed to be scrubbed to meet the NSPS of 1.2 lb SO₂/million Btu. NO_x and TSP emissions for all four plants are limited by NSPS to 0.7 lb/million Btu and 0.1 lb/million Btu, respectively.

D3.2.5 Analytical Methods

Each plant's predicted maximum impacts were rated on a probability basis for their acceptability, from an air quality licensing standpoint, with respect to each of the primary NAAQS and PSD increments. The probability scheme utilized appears in Table D3 - 2 and was designed on the basis of experienced subjective judgment. The first column represents the percent of a given NAAQS taken up by the CRSTER-predicted impact plus an assumed background of 20 percent of the NAAQS. The second column represents the amount of PSD increment taken up by the CRSTER-predicted plant impact only. The third column gives probability ratings which correspond to the first and second columns separately. These probabilities were defined allowing for the

considerable uncertainties inherent in modeling analyses of a preliminary nature such as have been performed in this study.

The probability ratings were developed by taking into account the margin by which the potential maximum screening model impacts exceeded the CRSTER impact predictions. In addition to this, consideration was given to the generally accepted fact that state-of-the-art air quality modeling is accurate to no better than a factor of two. As a particular plant's predicted impact approaches or exceeds the PSD increment, or similarly, the plant's impact plus background approaches the NAAQS, then the probability of licensing acceptability obviously decreases. Where PSD increments and/or NAAQS are predicted to be equaled, the probability is defined as 50 percent. Where PSD and/or NAAQS are predicted to be exceeded by a factor of two or greater, the probability is defined as zero. On the other hand, where a three-fold, or greater increase of the CRSTER impact would still not result in an NAAQS or PSD exceedence, the probability is set to 100 percent. The factor of three was adopted here as the effective limit of the potential non-conservatism in the CRSTER results. It is the factor by which the screening model one-hour maximum impacts exceed those of CRSTER.

D3.3 MODEL RESULTS AND COMMENTS

Based on the stack data contained in Table D3-1, the model PTMAX indicated that the maximum one-hour concentration for all four plant designs occurred with a wind speed of three m/sec and Pasquill stability class A. The distances between the stack and the location of concentration maxima for the four facilities ranged from 1.1 to 1.5 km. On the basis of this information, the model PTMTP was run for the four plant designs in order to ascertain

what effect a mixing height lid has on the worst case concentrations. Other than the incorporation of such a lid, the meteorological conditions were identical to those giving the worst case concentrations in the PTMAX run. The mixing height lid was set at ten meters above the plume centerline height to approximate maximum plume trapping conditions. The worst case one-hour concentrations and their source-receptor distances are presented in Table D3-3 for each plant design.

Interpretation of the results of the PTMTP model contained in Table D3-3 indicate a potential violation of the three and/or twenty-four hour SO₂ Class II PSD increments by either high sulfur coal facility. This interpretation is based on past experience and meteorological judgment since the model outputs only one hour averages. The reasoning is that, if the predicted 1105 micrograms per cubic meter SO₂ concentration (HS12) occurs at a particular location (receptor) only two hours out of twenty-four, the PSD increment is exceeded even if the wind carries the plume away from that location for the other twenty-two hours in the period. The increment is not violated, however, unless this or a similar set of circumstances occurs twice during a one year period. For Middletown climatology, the meteorological conditions causing the 1105 micrograms per cubic meter concentration are relatively rare and, although it is statistically possible for them to occur twice in one year, it is rather unlikely. The low sulfur coal plants worst case impacts are low enough so that there is no concern in this regard.

Examination of the results from the CRSTER model run in Table D3-4a showed no NAAQS or PSD (assuming the full increment is available) violations for SO₂. The results of the CRSTER analysis may be questioned because the three

and twenty-four hour averaged maximum concentrations for the 800 MWe plants (HS8 and LS8) are greater than the corresponding 1200 MWe plants (HS12 and LS12) maxima. On the basis of emission rates and stack parameters alone, this is a valid question; however, further probing into the meteorological conditions demonstrates a valid explanation for this apparent discrepancy. The periods in which the 800 MWe plants resulted in their highest concentration averages occurred on a day when ambient temperatures were extremely high over an interval of about ten hours, winds averaged about seven mps and there were very low mixing heights, ranging from about 300 to 900 meters. Plume rise calculations for a number of hours over this period demonstrated that for several of these hours, the 800 MWe and 1200 MWe high sulfur plants stack emissions rose above the lid (mixing height) resulting in zero impacts. During the fifteenth hour of the day, only the 1200 MWe plants emissions rose above the lid, resulting in zero impact. During this same hour, the final rise of the 800 MWe plants emissions were below the lid, resulting in the highest hourly concentration of the year. It is this one hour period that caused the apparent disagreement between the three hour average concentrations. The twenty-four hour average concentration discrepancy is likewise believed to be a result of this one hour period.

Results of the fumigation calculations, given in Table D3-5, show that concentrations for this case do not exceed those of the worst possible case, assuming the worst case concentrations persist for three hours at one receptor. Because of the more adverse effects of the trapping case, no further consideration was given to fumigation.

Based strictly on the assumptions of this study, no potential problem exists with respect to the TSP impacts of the four plants as may be seen from examination of Tables D3-3 and D3-4c. Considerable difficulty, however, may be encountered in complying with a one-hour NO_x NAAQS and PSD increment of 500 and $200 \mu\text{g}/\text{m}^3$, respectively as is demonstrated in Tables D3-3 and D3-4b. This estimation is based on assumed NO_x standards which are adopted for the purpose of this study. As of January 1, 1978, however, such a standard has not been promulgated. Each value represents an estimated average of the range of unofficially projected values for the standards which are expected to be ultimately promulgated.

D3.4 CONCLUSIONS

Table D3-6 provides the air quality acceptance probabilities estimated for the four qualified coal-fired plant designs located at the hypothetical Middletown site, with respect to each individual criteria pollutant NAAQS and PSD increment. This table indicates no potential licensing problem for TSP and little potential licensing problem with respect to SO_2 ; however, a much greater licensing risk is posed by NO_2 if one-hour NAAQS and PSD values similar to those assumed here are eventually promulgated. To lower the licensing risk to an acceptable level, significant capital expenditure for additional design features to control NO_x emissions may prove necessary.

The magnitude of high sulfur plant impacts relative to PSD increments under worst case meteorological conditions of Pasquill atmospheric stability class A and light winds suggest that design changes (increased removal efficiency, more reheat, or lower sulfur coal) may be required for proposed sites other than Middletown where worst case meteorological conditions may be prevalent.

Finally, it must be noted that a change in the site assumptions could significantly change the probabilities determined above. For example, high terrain relative to the plant grade, the presence of other major sources in the region or siting of the plant in or near a city could easily result in considerably lower acceptance probabilities for the four plant designs studied. In addition, the choice of another year of meteorological data or a data source other than that chosen to represent Middletown could significantly change the results of this analysis.

In consideration of the fact that the majority of power plant sites are not as ideally situated as Middletown, together with the possibility of future restrictive NO_x regulation, it is likely that the capital costs given in Tables 4-4 and 5-1 may be increased. Cost increases may be caused by the additional design features required to reduce emissions in order to achieve acceptable air quality impacts on sites of interest.

References:

1. Turner, D. B. and Busse, Adrian D., 1973: User's Guides to the Interactive Versions of Three Point Source Dispersion Programs: PTMAX, PTDIS and PTMTP. Meteorology Laboratory, National Environmental Research Center, Office of Research and Monitoring, U.S. EPA, Research Triangle Park, NC 27711.
2. EPA, 1977: User's Manual for Single-Source (CRSTER) Model EPA-450/2-77-013 Monitoring and Data Analysis Division, Source Receptor Analysis Branch, U.S. EPA, Office of Air and Waste Management, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711.
3. Budney, Lawrence J., 1977: Guidelines for Air Quality Maintenance Planning and Analysis, Vol. 10 (Revised): Procedures for Evaluating Air Quality Impact of New Stationary Sources. EPA-450/4-77-001, U.S. EPA, Office of Air and Waste Management, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711.

Effective Date - 1/1/78

TABLE D3-1

ENERGY ECONOMIC DATA BASE

EMISSION RATES AND STACK PARAMETERS

<u>Plant Model</u>	<u>Emission Rates</u>			<u>Stack Parameters</u>			
	<u>Q: SO₂</u> <u>(g/s)</u>	<u>Q: NO_x</u> <u>(g/s)</u>	<u>Q: Particulate</u> <u>(g/s)</u>	<u>T_s</u> <u>(K)</u>	<u>h_s</u> <u>(m)</u>	<u>d_s</u> <u>(m)</u>	<u>v_s</u> <u>(m/s)</u>
HS12	1834.56	1069.73	152.82	337.59	182.88	9.14	24.72
HS8	1217.16	709.85	101.41	337.59	182.88	7.62	23.60
LS12	1323.00	1108.81	158.40	405.37	182.88	9.14	29.44
LS8	876.96	734.45	104.92	405.37	182.88	7.62	28.08

Q: Emission Rate
 Ts: Stack Gas Temperature
 hs: Physical Stack Height
 ds: Stack Top Inside Diameter
 vs: Stack Gas Exit Velocity

TABLE D3-2

ENERGY ECONOMIC DATA BASE

PROBABILITY PERCENTAGES FOR AIR QUALITY ACCEPTANCE
AT RURAL^a MIDDLETOWN LOCATION

Air Quality Level ^b		Acceptance Probability Percentage ^e
% of NAAQS ^c	% of PSD Increment ^d	
20 - 53	0-33	100 ^f
60	50	90
70	60	80
80	70	70
90	80	60
100	100	50
120	120	40
140	140	30
160	160	20
180	180	10
200 or above	200 or above	0

- a. Rural implies non-industrialized, NAAQS attainment region with no other major sources.
- b. Based upon CRSTER air quality model results.
- c. Assumes CRSTER impact added to a background of 20% of NAAQS.
- d. Percentages based upon PSD Class II (availability of full PSD increment is assumed).
- e. Probability based subjectively on preliminary screening and CRSTER analyses with one year of offsite meteorological data.
- f. More realistically interpreted as "near 100%".

TABLE D3-3
ENERGY ECONOMIC DATA BASE
PTMTP MODEL RESULTS
WORST CASE HOURLY GROUND CONCENTRATIONS ($\mu\text{g}/\text{m}^3$)
(No Background Included)

	Model Type			
	<u>HS12</u>	<u>HS8</u>	<u>LS12</u>	<u>LS8</u>
Maximum SO ₂ Concentration	1105.0	934.0	425.3	376.5
Maximum NO _x Concentration	644.3	544.7	356.4	315.3
Maximum Part. Concentration	92.0	77.8	50.9	45.0
Distance to Maximum (km)	1.2	1.2	1.4	1.4

Effective Date - 1/1/78

TABLE D3-4a

ENERGY ECONOMIC DATA BASE
CRSTER DISPERSION MODEL RESULTS
SO₂ CONCENTRATIONS ($\mu\text{g}/\text{m}^3$)
(No Background Included)

	Plant Model				<u>NAAQS</u>	PSD <u>Increment</u>
	<u>HS12</u>	<u>HS8</u>	<u>LS12</u>	<u>LS8</u>		
Annual Mean	1.69 (17) ^a	1.46 (17)	0.618 (25)	0.586 (25)	80	20
24 h Maximum	34.6 (5)	39.4 (5)	13.6 (10.5)	12.4 (5)	365	91
3 h Maximum	167.0 (5)	177.0 (5)	69.1 (5)	74.0 (5)	1300	512
1 h Maximum	383.0 (5)	329.0 (5)	156.0 (5)	144.0 (5)	-	-

^a Numbers in parentheses give ring distance at which the concentration occurred.

Effective Date - 1/1/78

TABLE D3-4b
ENERGY ECONOMIC DATA BASE
CRSTER DISPERSION MODEL RESULTS
NO_x CONCENTRATIONS ($\mu\text{g}/\text{m}^3$)
(No Background Included)

	Plant Model				NAAQS	PSD Increment
	HS12	HS8	LS12	LS8		
Annual Mean	0.985 ^a	0.851	0.518	0.491	100 (Secondary 100)	-
24 h Maximum	20.2	23.0	11.4	10.4	-	-
8 h Maximum	60.6	55.5	34.2	27.1	-	-
3 h Maximum	97.4	103.0	57.9	62.0	-	-
1 h Maximum	223.0	192.0	131.0	121.0	Postponed until 1980	-

^a Distances at which concentrations occurred are the same as those for SO₂.

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Effective Date - 1/1/78

TABLE D3-4c

ENERGY ECONOMIC DATA BASE

CRSTER DISPERSION MODEL RESULTS

PARTICULATE MATTER ($\mu\text{g}/\text{m}^3$)
(No Background Included)

	Plant Model				NAAQS	PSD Increment
	<u>HS12</u>	<u>HS8</u>	<u>LS12</u>	<u>LS8</u>		
Annual Mean ^b	0.141 ^a	0.122	0.074	0.070	75	19
24 h Maximum	2.89	3.29	1.63	1.49	260 (Secondary 150)	37
8 h Maximum	8.66	7.93	4.89	3.87	-	-
3 h Maximum	13.9	14.7	8.27	8.86	-	-
1 h Maximum	31.9	27.4	18.7	17.3	-	-

a Distances at which concentrations occurred are the same as those for SO₂.

b The facility annual means are arithmetic while the means set by the standards are geometric means.

Effective Date - 1/1/78

TABLE D3-5

ENERGY ECONOMIC DATA BASE

FUMIGATION THREE HOUR AVERAGE CONCENTRATIONS ($\mu\text{g}/\text{m}^3$)
(No Background Included)

	Plant Model			
	<u>HS12</u>	<u>HS8</u>	<u>LS12</u>	<u>LS8</u>
SO ₂ 3 h Average	1007.0	841.4	349.9	347.2
NO _x 3 h Average	587.2	490.7	293.3	290.8
TSP 3 h Average	83.9	70.1	41.9	41.5
Distance (km)	46.4	41.1	62.0	54.0

Effective Date - 1/1/78

TABLE D3-6

ENERGY ECONOMIC DATA BASE

ASSESSMENT OF IMPACT ACCEPTABILITY RELATIVE TO AIR QUALITY LICENSING STANDPOINT
LICENSING PROBABILITY PERCENTAGES

Pollutant	Averaging Period	Plant Model							
		HS12		HS8		LS12		LS8	
		PSD	NAAQS	PSD	NAAQS	PSD	NAAQS	PSD	NAAQS
SO ₂	Annual	100	100	100	100	100	100	100	100
	24-Hour	90 ^a	100	90	100	100	100	100	100
	3-Hour	100	100	90	100	100	100	100	100
NO _x	Annual	b	100	b	100	b	100	b	100
	1-Hour	40 ^c	80 ^d	50	90	70	100	70	100
Particulate	Annual	100	100	100	100	100	100	100	100
	24-Hour	100	100	100	100	100	100	100	100

a Probability values interpolated from Table D-3.2 are rounded to next lower decile (i.e., 96% → 90%).

b Not Applicable

c PSD increment not yet issued - this analysis assumes 200 µg/m³.

d NAAQS standard not yet issued - this analysis assumes 500 µg/m³.

APPENDIX D-4

APPENDIX D-4

SYNTHETIC POWER PLANT FUELS BY THE SOLVENT REFINED COAL PROCESS

D4.1 INTRODUCTION

The plant and costs which are described in this Appendix are taken from "Recycle SRC Processing for Liquid and Solid Fuels," B. K. Schmid and D. M. Jackson, Gulf Mineral Resources Company, June, 1978. This information is the most recent available from Gulf Mineral Resources Company, a principal developer of the Solvent Refined Coal (SRC) process.

D4.2 TECHNICAL DESCRIPTION

Two process plants are described, representing the limits of plant design, producing liquid and solid fuels, respectively. A co-product (liquid plus solid fuels) plant would be similar to the solid fuel plant, with altered flow rates to produce the desired quantity of liquids.

The liquid fuel is a heavy fuel oil suitable for existing oil-fired plants without plant modifications. The solid fuel is similar to low-ash, low-sulfur coal, and can be fired in conventional coal-fired plants with only minor modifications to the plant.

D4.3 RECYCLE SRC (LIQUID) PROCESS

A schematic flow diagram of the Recycle SRC (Liquid) process as it is currently visualized for a large scale demonstration or commercial plant is shown in Figure D4.2. Some plant operating and production parameters are shown in Table D4-1.

Raw coal is pulverized and dried in the coal preparation area and then mixed with hot recycle slurry solvent from the process. The coal-recycle slurry mixture is pumped, with hydrogen, through a fired preheater to a dissolver. The ratio of hydrogen to coal is usually about 40,000 cubic feet per ton.

The temperature of the reactants at the outlet of the preheater is about 700-750°F. At this time the coal is already partially dissolved in the recycle slurry solvent, and the exothermic reactions of hydrogenation and hydrocracking have begun. The heat generated by these reactions in the dissolver further raises the temperature of the reactants to the range 820-870°F.

The dissolver effluent passes to a hot high pressure separator. The hot overhead vapor stream from this separator is cooled in a series of heat exchangers and additional vapor-liquid separation steps. The condensed liquid from these separators goes to the fractionation system. The non-condensed gas consists of unreacted hydrogen, methane, and other light hydrocarbons, plus hydrogen sulfide (H_2S) and carbon dioxide (CO_2). The gas is first sent to an acid gas treating unit for removal of H_2S and CO_2 . A portion of the treated gas is then further processed in a cryogenic unit for removal of much of the methane and other light hydrocarbons. The recovered hydrogen (90 percent pure) is added to the remaining gas from the acid treating step.

The resulting mixture of recycle gas, plus fresh make-up hydrogen from the gasifier train, is fed to the process. A mixture of methane and ethane recovered in the cryogenic unit is produced for sale as a pipeline gas, while propane and butane are recovered for sale as liquefied petroleum gas (LPG). The H_2S removed in the acid gas treating unit is converted to elemental sulfur in a standard Claus unit equipped with a tail-gas treating unit to insure compliance with environmental standards.

The liquid slurry from the hot high pressure separator is flashed to lower pressure and split into two major streams. One of these streams becomes the recycle solvent for the process; the other goes to the fractionation system for separation of the major products of the process.

In the fractionation system, the slurry product is distilled at atmospheric pressure to separate a naptha stream, a middle distillate stream, and a bottoms stream which goes to a vacuum flash system for further separation. The temperature of the feed to the fractionation system is maintained at a high enough level that no additional preheating is needed other than for startup operations. The overhead from the vacuum flash tower, together with middle distillate from the fractionator, makes up the major fuel oil product of the process. For operation in the lower range of solvent to coal ratios, a portion of this stream may be recycled to the feed slurry mixing tank to control the maximum solids content of the feed slurry.

The bottoms from the vacuum tower, consisting of all of the undissolved mineral residue plus the vacuum residue portion of the dissolved coal, go to an oxygen-blown gasifier for ultimate conversion to hydrogen. The synthesis gas produced in the gasifier goes through a shift conversion step for conversion of steam and carbon monoxide to H_2 plus CO_2 , and then to an acid gas removal step for removal of CO_2 and H_2S . The hydrogen (94 percent pure) is compressed and fed as make-up hydrogen to the preheater-dissolver.

D4.4 RECYCLE SRC (SOLID) PROCESS

A schematic flow diagram of the Recycle SRC (Solid) process is given in Figure D4.1. Plant parameters are shown in Table D4-1.

The general flow scheme from the slurry mix tank through the vapor-liquid separators and the hydrogen purification and gas recovery systems, is the same as for the Recycle SRC (Liquid) process. About 18 parts of solvent per 100 parts of dry coal are required. The major difference is that the dissolver slurry removed from the process loop is split, with one portion being

filtered to remove undissolved solids. The undissolved solids, wet with wash solvent, then rejoin the unfiltered slurry before entering the fractionator. The filtrate is then sent to a solids-free vacuum tower where distillate liquids are separated from the dissolved coal. The overhead liquid also goes to the same fractionator. The low-ash bottoms fraction from this vacuum tower is cooled and solidified for production as the 'clean' solid fuel. The fractionator separates a distillate and a wash solvent, the latter for recycle to the filters. The bottoms stream from the fractionator, a slurry containing process solvent, solid SRC, and undissolved solids, goes to a vacuum tower, where the process solvent is removed overhead. The bottoms fraction from the vacuum tower goes to the gasifier to produce hydrogen.

Filtration is used here to illustrate the solids separation step primarily because it is the only solids separation process that has been extensively used in pilot plant operations. Other methods of solids separation may be more suitable with the Recycle SRC process arrangement.

D4.5 ECONOMIC DESCRIPTION

Gulf Mineral Resources Company prepared conceptual commercial plant designs and estimated the capital and operating costs. The grass-roots plant is sized to be equivalent to a modern 100,000 barrel per day refinery.

Capital costs for the Solid and Liquid Recycle SRC Plants are shown in Table D4-2. The entry for 'Other Capital Costs' includes land, working capital, startup costs and licensing.

Operating and maintenance costs are estimated as \$83 million per year for the Liquid case and \$101 million per year for the Solid process.

The plant design is based on Western Kentucky coal, containing four percent sulfur and six percent ash. The coal is assumed to come from a mine adjacent to the plant, and is estimated to cost \$18 per ton, run-of-the-mine (\$20 per ton dry).

Gulf evaluated the product costs using 100 percent equity funding, a 12 percent discounted cash flow rate, 20 year plant life, and six percent per year escalation. Naphtha, LPG, and pipeline gas by-products were assumed to have the same value, per Btu, as the main product. Sulfur and phenols were assumed to have no value, with disposal costs offsetting any commercial value. The results of the Gulf calculation converted to November 1976 dollars, are shown in Table D4-3.

The estimates presented here are based on optimistic economic assumptions, and thus represent a lower limit on the cost of Recycle SRC fuel.

TABLE D4-1
ENERGY ECONOMIC DATA BASE
PLANT DATA SUMMARY

<u>INPUT</u>	<u>Recycle SRC Process</u>	
	<u>Liquid</u>	<u>Solid</u>
Size, Tons/Day of Coal ⁽¹⁾	30,000	30,000
<u>OUTPUT</u>		
Pipeline Gas, 10 ⁶ SCFD ⁽²⁾	36	20
Liquefied Petroleum Gas, bbl/day	7,700	3,700
Light Oil (Naptha), bbl/day	15,600	23,100
Fuel Oil, bbl/day ⁽³⁾	63,500	-
Solid Fuel, tons/day ⁽⁴⁾	-	13,050
Net Thermal Efficiency, Percent	70.3	73.4

(1) Western Kentucky Coal, 4% sulfur, 6% ash

(2) 1250-1300 Btu/scf

(3) 17,300 Btu/lb

(4) 16,000 Btu/lb

Effective Date - 1/1/78

TABLE D4-2
ENERGY ECONOMIC DATA BASE
TOTAL CAPITAL COSTS
(Millions of 1/78 Dollars)

<u>System</u>	<u>Recycle SRC Process</u>	
	<u>Liquid</u>	<u>Solid</u>
Coal Preparation	88	88
Hydrogenation	300	249
Hydrogen Recycle	99	35
Fractionation	24	34
Hydrogen Plant	301	223
Filtration	-	142
Product Solidification	-	24
Gas and Secondary Recovery	127	103
Utilities and Offsites	124	118
General Facilities	<u>83</u>	<u>83</u>
Subtotal	1146	1099
Other Capital Costs	<u>86</u>	<u>90</u>
TOTAL	1232	1189

TABLE D4-3
 ENERGY ECONOMIC DATA BASE
 CAPITAL COSTS
 (Millions of 11/76 Dollars)

<u>System</u>	<u>Recycle SRC Process</u> <u>Liquid</u>	<u>Solid</u>
Coal Preparation	81	81
Hydrogenation	276	229
Hydrogen Recycle	91	32
Fractionation	22	31
Hydrogen Plant	277	205
Filtration	-	131
Product Solidification	-	22
Gas and Secondary Recovery	117	95
Utilities and Offsites	114	109
General Facilities	<u>76</u>	<u>76</u>
Subtotal	1054	1011
Other Capital Costs	<u>79</u>	<u>83</u>
TOTAL	1133	1094

TABLE D4-3 (continued)
 ENERGY ECONOMIC DATA BASE
 SELLING PRICE
 (11/76 Dollars)

<u>Recycle SRC Process</u>	<u>\$/10⁶ Btu</u>
Liquid	2.38
Solid	2.34

Basis:

10 Percent Contingency
 12 Percent Discounted Cash Flow Rate
 6 Percent Per Year Escalation
 \$20/ton Coal (Dry)
 100 Percent Equity Funding
 20 Year Plant Life
 By-Product Values:
 Naphtha, LPG, Gas Btu Basis
 Sulfur, Phenols No Value

FIGURE D4.1

RECYCLE SRC (SOLID) PROCESS

FIGURE D4.2

RECYCLE SRC (LIQUID) PROCESS

APPENDIX E-1

APPENDIX E-1

INFLATION-FREE FUEL CYCLE COSTS FOR "THROWAWAY" AND RECYCLE CASES

INDEX OF TABLES

<u>Reactor</u>	<u>Fuel Cycle</u> **	<u>Bred Fuel</u> +	<u>Year of</u> <u>Startup</u>	<u>Table Number</u> *
PWR	U5(LE)/U-T	N/A	1987	E1 - 1a/1b
PWR	U5(LE)/U-T	N/A	2001	E1 - 2a/2b
PWR	U5(LE)+Pu(RE)/U	1	1991	E1 - 3a/3b
PWR	U5(LE)+Pu(RE)/U	1	2001	E1 - 4a/4b
PWR	U5(LE)+Pu(RE)/U	2	1991	E1 - 5a/5b
PWR	U5(LE)+Pu(RE)/U	2	2001	E1 - 6a/6b
HTGR	U5/U/Th-20%-T	N/A	1995	E1 - 7a/7b
HTGR	U5/U/Th-20%-T	N/A	2001	E1 - 8a/8b
HTGR	U5(DE)/U/Th-20%	None	1995	E1 - 9a/9b
HTGR	U5(DE)/U/Th-20%	None	2001	E1 - 10a/10b
PHWR	U5(NAT)/U-T	N/A	1995	E1 - 11a/11b
PHWR	U5(NAT)/U-T	N/A	2001	E1 - 12a/12b
PHWR	U5(SE)/U-T	N/A	1995	E1 - 13a/13b
PHWR	U5(SE)/U-T	N/A	2001	E1 - 14a/14b
LMFBR	Pu/U/U/U-HT	1	2001	E1 - 15a/15b
LMFBR	Pu/U/U/U-HT	2	2001	E1 - 16a/16b
LMFBR	Pu/U/U/U-HT	3	2001	E1 - 17a/17b
LMFBR	Pu/U/Th/Th-HT	1	2001	E1 - 18a/18b
LMFBR	Pu/U/Th/Th-HT	2	2001	E1 - 19a/19b

* "a" Tables are Input Components

"b" Tables are Output Components

** See Section 6, Table 6-21

+ See Appendix G

APPENDIX E-1 (cont'd)

INFLATION-FREE FUEL CYCLE COSTS FOR
"THROWAWAY" AND RECYCLE CASES

INDEX OF TABLES

<u>Reactor</u>	<u>Fuel Cycle</u> ^{**}	<u>Bred Fuel</u> ⁺ <u>Scenario</u>	<u>Year of</u> <u>Startup</u>	<u>Table Number</u> [*]
GCFR	Pu/U/U/U	1	2001	E1 - 20a/20b
GCFR	Pu/U/U/U	2	2001	E1 - 21a/21b
GCFR	Pu/U/U/U	3	2001	E1 - 22a/22b
GCFR	Pu/U/Th/Th	1	2001	E1 - 23a/23b
GCFR	Pu/U/Th/Th	2	2001	E1 - 24a/24b

* "a" Tables are Input Components

"b" Tables are Output Components

** See Section 6, Table 6-21

+ See Appendix G

TABLE E1-1a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : PWR-U5(LE)/U-T
Start Up : January 1, 1987
Bred Fuel Scenario: N/A

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1985	1990	1995	2000	2005	2010	2015	2020
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/1b U ₃ O ₈	45	56	60	62	63	64	65	66
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	\$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	177	177	177	177	177	177	177	177
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Repository	\$/KgH	18	18	16	16	16	16	16	16
.60	Disposal of Spent Fuel	\$/KgH	134	134	134	134	134	134	134	134

TABLE E1-1b
 ENERGY ECONOMIC DATA BASE
 OUTPUT NUCLEAR FUEL COST COMPONENTS
 No Escalation
 Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
 System : PWR-U5(LE)/U-T
 Start Up : January 1, 1987
 Bred Fuel Scenario: N/A

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	0.67	0.62	0.65	0.67	0.67	0.68	0.68	0.72
.10	Initial Fuel Loaded								
.11	Uranium Supply	0.47	0.50	0.53	0.55	0.55	0.56	0.56	0.59
.111	U3O8 Supply								
.112	UF6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.12	0.07	0.07	0.07	0.07	0.07	0.07	0.08
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
.60	Disposal of Spent Fuel	0.07	0.04	0.04	0.04	0.04	0.04	0.04	0.04

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E1-2a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : PWR-U5(LE)/U-T
Start Up : January 1, 2001
Bred Fuel Scenario: N/A

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	62	63	64	65	66	67	67	68
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	\$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	177	177	177	177	177	177	177	177
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Repository	\$/KgH	16	16	16	16	16	16	16	16
.60	Disposal of Spent Fuel	\$/KgH	134	134	134	134	134	134	134	134

TABLE E1-2b
 ENERGY ECONOMIC DATA BASE
 OUTPUT NUCLEAR FUEL COST COMPONENTS
 No Escalation
 Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
 System : PWR-U5 (LE)/U-T
 Start Up : January 1, 2001
 Bred Fuel Scenario: N/A

		OUTPUT QUANTITIES, \$/MBtu							30-YEAR
		ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							LEVELIZED
<u>Account No.</u>	<u>Account Description</u>	<u>1</u>	<u>5</u>	<u>10</u>	<u>15</u>	<u>20</u>	<u>25</u>	<u>30</u>	<u>TOTAL \$/MBtu</u>
.00	Total	0.76	0.67	0.68	0.68	0.69	0.70	0.70	0.76
.10	Initial Fuel Loaded								
.11	Uranium Supply	0.56	0.55	0.56	0.56	0.57	0.58	0.58	0.63
.111	U3O8 Supply								
.112	UF6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.12	0.07	0.07	0.07	0.07	0.07	0.07	0.08
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
.60	Disposal of Spent Fuel	0.07	0.04	0.04	0.04	0.04	0.04	0.04	0.04

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E1-3a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : PWR-U5(LE)+Pu(RE)/U
Start Up : January 1, 1991
Bred Fuel Scenario: 1

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1990	1995	2000	2005	2010	2015	2020	2025
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	56	60	62	63	64	65	66	67
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	\$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	177	177	177	177	177	177	177	177
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	18	16/20 ⁽¹⁾						
.60	Reprocessing	\$/KgH	280	248	209	200	200	200	200	200
.70	Disposal of Reprocessing Wastes	\$/KgH	62	62	62	62	62	62	62	62
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH								
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈	56	60	62	63	64	65	66	67
.812	Equivalent UF ₆ Conversion Services	\$/KgU	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.813	Equivalent Enrichment Services	\$/SWU	91	91	91	91	91	91	91	91
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0.5
.83	Bred U-233	Parity value								
.90	Refabrication of Recovered Fuel	\$/KgH	486	486	486	486	486	486	486	486

(1) makeup fuel/recycle fuel

TABLE E1-3b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : PWR-U5(LE)+Pu(RE)/U
Start Up : January 1, 1991
Bred Fuel Scenario: 1

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	0.86	0.65	0.58	0.57	0.56	0.58	0.47	0.66
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	0.52	0.44	0.36	0.35	0.34	0.35	0.27	0.44
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.00	0.00	0.00	0.00	0.00	0.00	-0.21	-0.01
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	0.12	0.06	0.05	0.05	0.05	0.05	0.08	0.12 ⁽⁴⁾
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
.60	Reprocessing	0.21	0.11	0.10	0.10	0.10	0.10	0.19	0.10
.70	Disposal of Reprocessing Wastes }								
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel	0.00	0.03	0.06	0.06	0.06	0.07	0.13	(4)

- (1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.
- (2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.
- (3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.
- (4) Levelized fabrication cost under account .20 includes refabrication cost of account .90.

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E1-4a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : PWR-U5 (LE)+Pu (RE)/U
Start Up : January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	62	63	64	65	66	67	67	68
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	\$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	177	177	177	177	177	177	177	177
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	16/20 ⁽¹⁾							
.60	Reprocessing	\$/KgH	208	200	200	200	200	200	200	200
.70	Disposal of Reprocessing Wastes	\$/KgH	62	62	62	62	62	62	62	62
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH								
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈	62	63	64	65	66	67	67	68
.812	Equivalent UF ₆ Conversion Services	\$/KgU	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.813	Equivalent Enrichment Services	\$/SWU	91	91	91	91	91	91	91	91
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0.5
.83	Bred U-233	Parity value								
.90	Refabrication of Recovered Fuel	\$/KgH	486	486	486	486	486	486	486	486

(1) makeup fuel/recycle fuel

TABLE E1-4b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : PWR-U5(LE)+Pu(RE)/U
Start Up : January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	0.86	0.66	0.59	0.58	0.57	0.58	0.47	0.67
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	0.56	0.46	0.37	0.36	0.35	0.35	0.27	0.45
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.00	0.00	0.00	0.00	0.00	0.00	-0.22	-0.01
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	0.12	0.06	0.05	0.05	0.05	0.05	0.03	0.12 ⁽⁴⁾
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
.60	Reprocessing								
.70	Disposal of Reprocessing Wastes }	0.17	0.10	0.10	0.10	0.10	0.10	0.20	0.10
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel	0.00	0.03	0.06	0.06	0.06	0.07	0.13	(4)

(1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.

(2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.

(3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.

(4) Levelized fabrication cost under account .20 includes refabrication cost of account .90.

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E1-5a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : PWR-U5(LE)+Pu(RE)/U
Start Up : January 1, 1991
Bred Fuel Scenario: 2

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1990	1995	2000	2005	2010	2015	2020	2025
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	56	60	62	63	64	65	66	67
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	\$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	177	177	177	177	177	177	177	177
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	18	16/20 ⁽¹⁾						
.60	Reprocessing	\$/KgH	280	248	208	200	200	200	200	200
.70	Disposal of Reprocessing Wastes	\$/KgH	62	62	62	62	62	62	62	62
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH								
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈	56	60	62	63	64	65	66	67
.812	Equivalent UF ₆ Conversion Services	\$/KgU	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.813	Equivalent Enrichment Services	\$/SWU	91	91	91	91	91	91	91	91
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	1.2
.83	Bred U-233	Parity value								
.90	Refabrication of Recovered Fuel	\$/KgH	486	486	486	486	486	486	486	486

(1) makeup fuel/recycle fuel

TABLE E1-5b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : PWR-U5(LE)+Pu(RE)/U
Start Up : January 1, 1991
Bred Fuel Scenario: 2

Account No.	Account Description	OUTPUT QUANTITIES, \$/Mbtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/Mbtu
		1	5	10	15	20	25	30	
.00	Total	0.86	0.65	0.58	0.57	0.56	0.58	0.17	0.65
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	0.52	0.44	0.36	0.35	0.34	0.35	0.27	0.44
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.00	0.00	0.00	0.00	0.00	0.00	-0.52	-0.02
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	0.12	0.06	0.05	0.05	0.05	0.05	0.08	0.12 ⁽⁴⁾
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
.60	Reprocessing	0.21	0.11	0.10	0.10	0.10	0.10	0.20	0.10
.70	Disposal of Reprocessing Wastes								
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel	0.00	0.03	0.06	0.06	0.06	0.07	0.13	(4)

- (1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.
- (2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.
- (3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.
- (4) Levelized fabrication cost under account .20 includes refabrication cost of account .90.

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E1-6a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : PWR-U5 (LE)+Pu (RE)/U
Start Up : January 1, 2001
Bred Fuel Scenario: 2

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	62	63	64	65	66	67	67	68
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	\$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	177	177	177	177	177	177	177	177
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	16/20							
.60	Reprocessing	\$/KgH	208	200	200	200	200	200	200	200
.70	Disposal of Reprocessing Wastes	\$/KgH	62	62	62	62	62	62	62	62
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH								
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈	62	63	64	65	66	67	67	68
.812	Equivalent UF ₆ Conversion Services	\$/KgU	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.813	Equivalent Enrichment Services	\$/SWU	91	91	91	91	91	91	91	91
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	1.2
.83	Bred U-233	Parity value								
.90	Refabrication of Recovered Fuel	\$/KgH	486	486	486	486	486	486	486	486

(1) makeup fuel/recycle fuel

TABLE E1-6b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date January 1, 1978
System PWR-U5(LE)+Pu(RE)/U
Start Up January 1, 2001
Bred Fuel Scenario 2

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	0.86	0.66	0.59	0.58	0.57	0.58	0.17	0.66
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	0.56	0.46	0.37	0.36	0.35	0.35	0.27	0.45
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.00	0.00	0.00	0.00	0.00	0.00	-0.52	-0.02
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	0.12	0.06	0.05	0.05	0.05	0.05	0.08	0.12 ⁽⁴⁾
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
.60	Reprocessing	0.17	0.10	0.10	0.10	0.10	0.10	0.20	0.10
.70	Disposal of Reprocessing Wastes }								
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel	0.00	0.03	0.06	0.06	0.06	0.07	0.13	(4)

(1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.

(2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.

(3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.

(4) Levelized fabrication cost under account .20 includes refabrication cost of account .90.

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E1-7a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : HTGR-U5/U/Th-20%-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1990	1995	2000	2005	2010	2015	2020	2025
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	56	60	62	63	64	65	66	67
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	\$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	365	488	488	488	488	488	488	488
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Repository	\$/KgH	180/250	(1)						
.60	Disposal of Spent Fuel	\$/KgH	370	370	370	370	370	370	370	370

(1) initial core fuel/reload fuel

TABLE E1-7b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : HTGR-U5/U/Th-20%-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	0.91	0.63	0.65	0.65	0.66	0.66	0.67	0.75
.10	Initial Fuel Loaded								
.11	Uranium Supply	0.69	0.54	0.56	0.56	0.57	0.57	0.58	0.65
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.10	0.05	0.05	0.05	0.05	0.05	0.05	0.06
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.02
.60	Disposal of Spent Fuel	0.08	0.02	0.02	0.02	0.02	0.02	0.02	0.02

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E1-8a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : HTGR-U5/U/Th-20%-T
Start Up : January 1, 2001
Bred Fuel Scenario: N/A

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	62	63	64	65	66	67	67	68
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	\$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	365	488	488	488	488	488	488	488
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Repository	\$/KgH	180/250 ⁽¹⁾							
.60	Disposal of Spent Fuel	\$/KgH	370	370	370	370	370	370	370	370

(1) initial core fuel/reload fuel

TABLE E1-8b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : HTGR-U5/U/Th-20%-T
Start Up : January 1, 2001
Bred Fuel Scenario: N/A

		OUTPUT QUANTITIES, \$/MBtu							30-YEAR
		ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							LEVELIZED
Account No.	Account Description	1	5	10	15	20	25	30	TOTAL \$/MBtu
.00	Total	0.93	0.64	0.66	0.66	0.66	0.67	0.67	0.76
.10	Initial Fuel Loaded								
.11	Uranium Supply	0.71	0.55	0.57	0.57	0.57	0.58	0.58	0.66
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.10	0.05	0.05	0.05	0.05	0.05	0.05	0.06
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.02
.60	Disposal of Spent Fuel	0.08	0.02	0.02	0.02	0.02	0.02	0.02	0.02

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E1-9a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : HTGR-U5(DE)/U/Th-20%
Start Up : January 1, 1995
Bred Fuel Scenario: None

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1990	1995	2000	2005	2010	2015	2020	2025
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	56	60	62	63	64	65	66	67
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	\$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value	0	0	0	0	0	0	0	0
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	365	488	488	488	488	488	488	488
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	180/250							
.60	Reprocessing	\$/KgH	519/720							
.70	Disposal of Reprocessing Wastes	\$/KgH	117	117	117	117	117	117	117	117
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value	0	0	0	0	0	0	0	1.17
.90	Refabrication of Recovered Fuel	\$/KgH	1430	1430	1430	1430	1430	1430	1430	1430

(1) initial core fuel/reload fuel

TABLE E1-9b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : HTGR-U5(DE)/U/Th-20%
Start Up : January 1, 1995
Bred Fuel Scenario: None

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu							30-YEAR LEVELIZED TOTAL \$/MBtu
		ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							
		1	5	10	15	20	25	30	
.00	Total	1.01	0.59	0.62	0.63	0.64	0.67	0.65	0.72
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	0.68	0.45	0.48	0.49	0.49	0.52	0.50	0.56
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	0.11	0.04	0.04	0.04	0.04	0.04	0.04	0.08 ⁽⁴⁾
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.05	0.02	0.02	0.02	0.02	0.02	0.02	0.02
.60	Reprocessing	0.17	0.06	0.06	0.06	0.07	0.07	0.07	0.06
.70	Disposal of Reprocessing Wastes }								
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel	0.00	0.02	0.02	0.02	0.02	0.02	0.02	(4)

(1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.

(2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.

(3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.

(4) Levelized fabrication cost under account .20 includes refabrication cost of account .90.

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E1-10a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : HTGR-U5 (DE)/U/Th-20%
Start Up : January 1, 2001
Bred Fuel Scenario: None

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	62	63	64	65	66	67	67	68
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	\$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value	0	0	0	0	0	0	0	0
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	365	488	488	488	488	488	488	488
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	180/250 ⁽¹⁾							
.60	Reprocessing	\$/KgH	519/720 ⁽¹⁾							
.70	Disposal of Reprocessing Wastes	\$/KgH	117	117	117	117	117	117	117	117
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value	0	0	0	0	0	0	0	1.17
.90	Refabrication of Recovered Fuel	\$/KgH	1430	1430	1430	1430	1430	1430	1430	1430

(1) initial core fuel/reload fuel

TABLE E1-10b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : HTGR-U5(DE)/U/Th-20%
Start Up : January 1, 2001
Bred Fuel Scenario None

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu							30-YEAR LEVELIZED TOTAL \$/MBtu
		ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							
		1	5	10	15	20	25	30	
.00	Total	1.03	0.59	0.63	0.63	0.64	0.64	1.12	0.73
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	0.70	0.45	0.49	0.49	0.49	0.49	0.85	0.57
.111	U3O8 Supply								
.112	UF6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	0.11	0.04	0.04	0.04	0.04	0.04	0.07	0.08 ⁽⁴⁾
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.05	0.02	0.02	0.02	0.02	0.02	0.04	0.02
.60	Reprocessing	0.17	0.06	0.06	0.06	0.07	0.07	0.13	0.06
.70	Disposal of Reprocessing Wastes }								
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U3O8 Supply								
.812	Equivalent UF6 Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel	0.00	0.02	0.02	0.02	0.02	0.02	0.03	(4)

(1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.

(2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.

(3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.

(4) Levelized fabrication cost under account .20 includes refabrication cost of account .90.

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E1-11a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : CANDU U5(NAT)/U-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1990	1995	2000	2005	2010	2015	2020	2025
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	56	60	62	63	64	65	66	67
.112	UF ₆ Conversion Services	\$/KgU as UF ₆								
.113	Enrichment Services	\$/SWU								
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	104	104	104	104	104	104	104	104
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Repository	\$/KgH	13	12	12	12	12	12	12	12
.60	Disposal of Spent Fuel	\$/KgH	83	83	83	83	83	83	83	83

TABLE E1-11b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : CANDU-U5 (NAT)/U-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	0.95	0.68	0.69	0.70	0.70	0.70	0.71	0.72
.10	Initial Fuel Loaded								
.11	Uranium Supply	0.47	0.34	0.34	0.35	0.35	0.35	0.36	0.37
.111	U3O8 Supply								
.112	UF6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.30	0.21	0.21	0.21	0.21	0.21	0.21	0.22
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
.60	Disposal of Spent Fuel	0.16	0.11	0.12	0.12	0.12	0.12	0.12	0.11

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E-12a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : CANDU US (NAT)/U-T
Start Up : January 1, 2001
Bred Fuel Scenario: N/A

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	62	63	64	65	66	67	67	68
.112	UF ₆ Conversion Services	\$/KgU as UF ₆								
.113	Enrichment Services	\$/SWU								
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	104	104	104	104	104	104	104	104
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Repository	\$/KgH	12	12	12	12	12	12	12	12
.60	Disposal of Spent Fuel	\$/KgH	83	83	83	83	83	83	83	83

TABLE E1-12b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : CANDU-U5(NAT)/U-T
Start Up : January 1, 2001
Bred Fuel Scenario: N/A

		OUTPUT QUANTITIES, \$/MBtu							30-YEAR
		ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							LEVELIZED
<u>Account No.</u>	<u>Account Description</u>	<u>1</u>	<u>5</u>	<u>10</u>	<u>15</u>	<u>20</u>	<u>25</u>	<u>30</u>	<u>TOTAL \$/MBtu</u>
.00	Total	0.96	0.69	0.70	0.71	0.71	0.71	0.72	0.73
.10	Initial Fuel Loaded								
.11	Uranium Supply	0.48	0.35	0.35	0.36	0.36	0.36	0.37	0.38
.111	U3O8 Supply								
.112	UF6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.30	0.21	0.21	0.21	0.21	0.21	0.21	0.22
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
.60	Disposal of Spent Fuel	0.16	0.11	0.12	0.12	0.12	0.12	0.12	0.11

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E1-13a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : CANDU-U5(SE)/U-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1990	1995	2000	2005	2010	2015	2020	2025
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	56	60	62	63	64	65	66	67
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	\$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	104	104	104	104	104	104	104	104
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Repository	\$/KgH	13	12	12	12	12	12	12	12
.60	Disposal of Spent Fuel	\$/KgH	83	83	83	83	83	83	83	83

TABLE E1-13b
 ENERGY ECONOMIC DATA BASE
 OUTPUT NUCLEAR FUEL COST COMPONENTS
 No Escalation
 Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
 System : CANDU-U5(SE)/U-T
 Start Up : January 1, 1995
 Bred Fuel Scenario: N/A

		OUTPUT QUANTITIES, \$/MBtu							30-YEAR
		ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							LEVELIZED
<u>Account No.</u>	<u>Account Description</u>	<u>1</u>	<u>5</u>	<u>10</u>	<u>15</u>	<u>20</u>	<u>25</u>	<u>30</u>	<u>TOTAL \$/MBtu</u>
.00	Total	0.59	0.35	0.36	0.36	0.37	0.37	0.37	0.40
.10	Initial Fuel Loaded								
.11	Uranium Supply	0.30	0.25	0.25	0.25	0.26	0.26	0.26	0.28
.111	U3O8 Supply								
.112	UF6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.18	0.06	0.06	0.06	0.06	0.06	0.06	0.08
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
.60	Disposal of Spent Fuel	0.10	0.03	0.04	0.04	0.04	0.04	0.04	0.03

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E1-14a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : CANDU U5(SE)/U-T
Start Up : January 1, 2001
Bred Fuel Scenario: N/A

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	62	63	64	65	66	67	67	68
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	\$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	104	104	104	104	104	104	104	104
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Repository	\$/KgH	12	12	12	12	12	12	12	12
.60	Disposal of Spent Fuel	\$/KgH	83	83	83	83	83	83	83	83

TABLE E1-14b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : CANDU-U5(SE)/U-T
Start Up : January 1, 2001
Bred Fuel Scenario: N/A

		OUTPUT QUANTITIES, \$/MBtu							30-YEAR
		ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							LEVELIZED
Account No.	Account Description	1	5	10	15	20	25	30	TOTAL \$/MBtu
.00	Total	0.60	0.35	0.36	0.36	0.37	0.37	0.37	0.40
.10	Initial Fuel Loaded								
.11	Uranium Supply	0.31	0.25	0.25	0.25	0.26	0.26	0.26	0.28
.111	U3O8 Supply								
.112	UF6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.18	0.06	0.06	0.06	0.06	0.06	0.06	0.08
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
.60	Disposal of Spent Fuel	0.10	0.03	0.04	0.04	0.04	0.04	0.04	0.03

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E1-15a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : LMFBR-Pu/U/U/U-HT
Start Up : January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/1b U ₃ O ₈								
.112	UF ₆ Conversion Services	\$/KgU as UF ₆								
.113	Enrichment Services	\$/SWU								
.114	Depleted U Supply	\$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH								
.21	Core Fabrication	\$/KgH	769	769	769	769	769	769	769	769
.22	Axial Blanket Fabrication	\$/KgH	49	49	49	49	49	49	49	49
.23	Radial Blanket Fabrication	\$/KgH	177	177	177	177	177	177	177	177
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	94	94	94	94	94	94	94	94
.60	Reprocessing	\$/KgH	370	326	271	260	260	260	260	260
.70	Disposal of Reprocessing Wastes	\$/KgH	194	194	194	194	194	194	194	194
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/1b U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value								
.90	Refabrication of Recovered Fuel	\$/KgH								

TABLE E1-15b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : LMFBR-Pu/U/U/U-HT
Start Up : January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	0.69	0.38	0.36	0.36	0.36	0.36	0.36	0.39
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	0.26	0.16	0.16	0.16	0.16	0.16	0.16	0.18 ⁽⁴⁾
.21	Core Fabrication	0.20	0.13	0.13	0.13	0.13	0.13	0.13	
.22	Axial Blanket Fabrication	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
.23	Radial Blanket Fabrication	0.05	0.02	0.02	0.02	0.02	0.02	0.02	
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.07	0.03	0.03	0.03	0.03	0.03	0.03	0.04
.60	Reprocessing								
.70	Disposal of Reprocessing Wastes }	0.36	0.19	0.17	0.17	0.17	0.17	0.17	0.17
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel								

- (1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.
- (2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.
- (3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.
- (4) Includes fabrication of core, axial blanket and radial blanket (account .21, .22 and .23).

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E1-16a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : LMFBR-Pu/U/U/U-HT
Start Up : January 1, 2001
Bred Fuel Scenario: 2

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	62							
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	4.7							
.113	Enrichment Services	\$/SWU	91							
.114	Depleted U Supply	\$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	0.5	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH								
.21	Core Fabrication	\$/KgH	769	769	769	769	769	769	769	769
.22	Axial Blanket Fabrication	\$/KgH	49	49	49	49	49	49	49	49
.23	Radial Blanket Fabrication	\$/KgH	177	177	177	177	177	177	177	177
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	94	94	94	94	94	94	94	94
.60	Reprocessing	\$/KgH	370	326	271	260	260	260	260	260
.70	Disposal of Reprocessing Wastes	\$/KgH	194	194	194	194	194	194	194	194
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value								
.90	Refabrication of Recovered Fuel	\$/KgH								

TABLE E1-16b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : LMFBR-Pu/U/U-U-HT
Start Up : January 1, 2001
Bred Fuel Scenario: 2

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	1.78	0.38	0.36	0.36	0.36	0.36	0.36	0.47
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	1.09	0.00	0.00	0.00	0.00	0.00	0.00	0.08
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	0.26	0.16	0.16	0.16	0.16	0.16	0.16	0.18 ⁽⁴⁾
.21	Core Fabrication	0.20	0.13	0.13	0.13	0.13	0.13	0.13	
.22	Axial Blanket Fabrication	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
.23	Radial Blanket Fabrication	0.05	0.02	0.02	0.02	0.02	0.02	0.02	
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.07	0.03	0.03	0.03	0.03	0.03	0.03	0.04
.60	Reprocessing	0.36	0.19	0.17	0.17	0.17	0.17	0.17	0.17
.70	Disposal of Reprocessing Wastes }								
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel								

- (1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.
- (2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.
- (3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.
- (4) Includes fabrication of core, axial blanket and radial blanket (account .21, .22 and .23).

Note: The 30-Year Levelized Costs Include Indirect Costs.

TABLE E1-17a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : LMFBR-Pu/U/U-U-HT
Start Up : January 1, 2001
Bred Fuel Scenario: 3

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	62	63	64	65	66	67	67	68
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	\$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	\$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH								
.21	Core Fabrication	\$/KgH	769	769	769	769	769	769	769	769
.22	Axial Blanket Fabrication	\$/KgH	49	49	49	49	49	49	49	49
.23	Radial Blanket Fabrication	\$/KgH	177	177	177	177	177	177	177	177
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	94	94	94	94	94	94	94	94
.60	Reprocessing	\$/KgH	370	326	271	260	260	260	260	260
.70	Disposal of Reprocessing Wastes	\$/KgH	194	194	194	194	194	194	194	194
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
.83	Bred U-233	Parity value								
.90	Refabrication of Recovered Fuel	\$/KgH								

TABLE E1-17b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : LMFBR-Pu/U/U-U-HT
Start Up : January 1, 2001
Bred Fuel Scenario: 3

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	0.84	0.40	0.40	0.38	0.38	0.38	0.40	0.73
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.15	0.02	0.03	0.01	0.01	0.01	0.03	0.34
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	0.26	0.16	0.16	0.16	0.16	0.16	0.16	0.18 ⁽⁴⁾
.21	Core Fabrication	0.20	0.13	0.13	0.13	0.13	0.13	0.13	
.22	Axial Blanket Fabrication	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
.23	Radial Blanket Fabrication	0.05	0.02	0.02	0.02	0.02	0.02	0.02	
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.07	0.03	0.04	0.04	0.04	0.04	0.04	0.04
.60	Reprocessing								
.70	Disposal of Reprocessing Wastes }	0.36	0.19	0.17	0.17	0.17	0.17	0.17	0.17
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel								

- (1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.
- (2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.
- (3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.
- (4) Includes fabrication of core, axial blanket and radial blanket (account .21,.22 and .23)

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E1-18a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : LMFBR-Pu/U/Th/Th-HT
Start Up : January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.112	UF ₆ Conversion Services	\$/KgU as UF ₆								
.113	Enrichment Services	\$/SWU								
.114	Depleted U Supply	\$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value	0	0	0	0	0	0	0	0
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH								
.21	Core Fabrication	\$/KgH	769	769	769	769	769	769	769	769
.22	Axial Blanket Fabrication	\$/KgH	79	79	79	79	79	79	79	79
.23	Radial Blanket Fabrication	\$/KgH	207	207	207	207	207	207	207	207
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	94	94	94	94	94	94	94	94
.60	Reprocessing	\$/KgH	370	326	271	260	260	260	260	260
.70	Disposal of Reprocessing Wastes	\$/KgH	194	194	194	194	194	194	194	194
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value	0	0	0	0	0	0	0	0
.90	Refabrication of Recovered Fuel	\$/KgH								

TABLE E1-18b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : LMFBR-Pu/U/Th/Th-HT
Start Up : January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	0.90	0.46	0.45	0.45	0.45	0.45	0.45	0.48
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	0.36	0.20	0.20	0.20	0.20	0.20	0.20	
.21	Core Fabrication	0.28	0.17	0.17	0.17	0.17	0.17	0.17	0.23 ⁽⁴⁾
.22	Axial Blanket Fabrication	0.02	0.01	0.01	0.01	0.01	0.01	0.01	
.23	Radial Blanket Fabrication	0.06	0.02	0.02	0.02	0.02	0.02	0.02	
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.08	0.04	0.04	0.04	0.04	0.04	0.04	0.04
.60	Reprocessing								
.70	Disposal of Reprocessing Wastes }	0.46	0.22	0.21	0.21	0.21	0.21	0.21	0.21
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel								

- (1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.
- (2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.
- (3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.
- (4) Includes fabrication of core, axial blanket and radial blanket (account .21, .22 and .23)

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E1-19a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : LMFBR-Pu/U/Th/Th-HT
Start Up : January 1, 2001
Bred Fuel Scenario: 2

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/1b U ₃ O ₈	62	63	64	65	66	67	67	68
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	\$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	\$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
.13	U-233 Supply	Parity value	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH								
.21	Core Fabrication	\$/KgH	769	769	769	769	769	769	769	769
.22	Axial Blanket Fabrication	\$/KgH	79	79	79	79	79	79	79	79
.23	Radial Blanket Fabrication	\$/KgH	207	207	207	207	207	207	207	207
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	94	94	94	94	94	94	94	94
.60	Reprocessing	\$/KgH	370	326	271	260	260	260	260	260
.70	Disposal of Reprocessing Wastes	\$/KgH	194	194	194	194	194	194	194	194
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/1b U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
.83	Bred U-233	Parity value	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17
.90	Refabrication of Recovered Fuel	\$/KgH								

TABLE E1-19b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : LMFBR-Pu/U/Th/Th-HT
Start Up : January 1, 2001
Bred Fuel Scenario: 2

Account No.	Account Description	OUTPUT QUANTITIES, \$/Mbtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/Mbtu
		1	5	10	15	20	25	30	
.00	Total	0.96	0.42	0.41	0.40	0.40	0.40	0.41	0.77
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	-0.32	-0.28	-0.28	-0.28	-0.28	-0.29	-0.30	-0.25
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.38	0.23	0.24	0.23	0.23	0.24	0.26	0.54
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	0.36	0.20	0.20	0.20	0.20	0.20	0.20	
.21	Core Fabrication	0.28	0.17	0.17	0.17	0.17	0.17	0.17	0.23 ⁽⁴⁾
.22	Axial Blanket Fabrication	0.02	0.01	0.01	0.01	0.01	0.01	0.01	
.23	Radial Blanket Fabrication	0.06	0.02	0.02	0.02	0.02	0.02	0.02	
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.08	0.04	0.04	0.04	0.04	0.04	0.04	0.04
.60	Reprocessing	0.46	0.22	0.21	0.21	0.21	0.21	0.21	0.21
.70	Disposal of Reprocessing Wastes								
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel								

(1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.

(2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.

(3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.

(4) Includes fabrication of core, axial blanket and radial blanket (account .21, .22 and .23)

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E1-20a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : GCFR-Pu/U/U/U
Start Up : January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.112	UF ₆ Conversion Services	\$/KgU as UF ₆								
.113	Enrichment Services	\$/SWU								
.114	Depleted U Supply	\$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH								
.21	Core Fabrication	\$/KgH	842	842	842	842	842	842	842	842
.22	Axial Blanket Fabrication	\$/KgH	49	49	49	49	49	49	49	49
.23	Radial Blanket Fabrication	\$/KgH	177	177	177	177	177	177	177	177
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	94	94	94	94	94	94	94	94
.60	Reprocessing	\$/KgH	370	326	271	260	260	260	260	260
.70	Disposal of Reprocessing Wastes	\$/KgH	194	194	194	194	194	194	194	194
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value								
.90	Refabrication of Recovered Fuel	\$/KgH								

TABLE E1-20b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : GCFR-Pu/U/U/U
Start Up : January 1, 2001
Bred Fuel Scenario: 1

		OUTPUT QUANTITIES, \$/MBtu							30-YEAR
		ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							LEVELIZED
Account No.	Account Description	1	5	10	15	20	25	30	TOTAL \$/MBtu
.00	Total	0.95	0.44	0.42	0.42	0.42	0.42	0.42	0.45
.10	Initial Fuel Loaded								
.11	Uranium Supply(1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.111	U3O8 Supply								
.112	UF6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply(2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.13	U-233 Supply(3)								
.14	Thorium Supply								
.20	Fabrication	0.31	0.16	0.16	0.16	0.16	0.16	0.16	0.20(4)
.21	Core Fabrication	0.20	0.11	0.11	0.11	0.11	0.11	0.11	
.22	Axial Blanket Fabrication	0.02	0.01	0.01	0.01	0.01	0.01	0.01	
.23	Radial Blanket Fabrication	0.09	0.04	0.04	0.04	0.04	0.04	0.04	
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04
.60	Reprocessing								
.70	Disposal of Reprocessing Wastes }	0.54	0.24	0.22	0.22	0.22	0.22	0.22	0.21
.80	Final Fuel Recovered (Credits)								
.81	Uranium(1)								
.811	Equivalent U3O8 Supply								
.812	Equivalent UF6 Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium(2)								
.83	Bred U-233(3)								
.90	Refabrication of Recovered Fuel								

- (1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.
- (2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.
- (3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.
- (4) Includes fabrication of core, axial blanket and radial blanket (account .21, .22 and .23)

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E1-21a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : GCFR-Pu/U/U/U
Start Up : January 1, 2001
Bred Fuel Scenario: 2

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	62							
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	4.7							
.113	Enrichment Services	\$/SWU	91							
.114	Depleted U Supply	\$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	0.5	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH								
.21	Core Fabrication	\$/KgH	842	842	842	842	842	842	842	842
.22	Axial Blanket Fabrication	\$/KgH	49	49	49	49	49	49	49	49
.23	Radial Blanket Fabrication	\$/KgH	177	177	177	177	177	177	177	177
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	94	94	94	94	94	94	94	94
.60	Reprocessing	\$/KgH	370	326	271	260	260	260	260	260
.70	Disposal of Reprocessing Wastes	\$/KgH	194	194	194	194	194	194	194	194
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value								
.90	Refabrication of Recovered Fuel	\$/KgH								

TABLE E1-21b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : GCFR-Pu/U/U/U
Start Up : January 1, 2001
Bred Fuel Scenario: 2

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	1.93	0.44	0.42	0.42	0.42	0.42	0.42	0.54
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.09
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	0.31	0.16	0.16	0.16	0.16	0.16	0.16	
.21	Core Fabrication	0.20	0.11	0.11	0.11	0.11	0.11	0.11	0.20 ⁽⁴⁾
.22	Axial Blanket Fabrication	0.02	0.01	0.01	0.01	0.01	0.01	0.01	
.23	Radial Blanket Fabrication	0.09	0.04	0.04	0.04	0.04	0.04	0.04	
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04
.60	Reprocessing	0.54	0.24	0.22	0.22	0.22	0.22	0.22	0.21
.70	Disposal of Reprocessing Wastes }								
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel								

- (1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.
- (2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.
- (3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.
- (4) Includes fabrication of core, axial blanket and radial blanket (account .21, .22 and .23)

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E1-22a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : GCFR-Pu/U/U/U
Start Up : January 1, 2001
Bred Fuel Scenario: 3

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	62	63	64	65	66	67	67	68
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	\$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	\$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH								
.21	Core Fabrication	\$/KgH	842	842	842	842	842	842	842	842
.22	Axial Blanket Fabrication	\$/KgH	49	49	49	49	49	49	49	49
.23	Radial Blanket Fabrication	\$/KgH	177	177	177	177	177	177	177	177
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	94	94	94	94	94	94	94	94
.60	Reprocessing	\$/KgH	370	326	271	260	260	260	260	260
.70	Disposal of Reprocessing Wastes	\$/KgH	194	194	194	194	194	194	194	194
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
.83	Bred U-233	Parity value								
.90	Refabrication of Recovered Fuel	\$/KgH								

TABLE E1-22b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : GCFR-Pu/U/U/U
Start Up : January 1, 2001
Bred Fuel Scenario: 3

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	0.67	0.22	0.21	0.21	0.20	0.20	0.21	0.62
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	-0.28	-0.23	-0.22	-0.22	-0.23	-0.23	-0.22	0.17
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	0.31	0.16	0.16	0.16	0.16	0.16	0.16	0.20 ⁽⁴⁾
.21	Core Fabrication	0.20	0.11	0.11	0.11	0.11	0.11	0.11	
.22	Axial Blanket Fabrication	0.02	0.01	0.01	0.01	0.01	0.01	0.01	
.23	Radial Blanket Fabrication	0.09	0.04	0.04	0.04	0.04	0.04	0.04	
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.10	0.05	0.05	0.05	0.05	0.05	0.05	0.04
.60	Reprocessing								
.70	Disposal of Reprocessing Wastes }	0.54	0.24	0.22	0.22	0.22	0.22	0.22	0.21
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel								

(1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.

(2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.

(3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.

(4) Includes fabrication of core, axial blanket and radial blanket (account .21, .22 and .23)

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E1-23a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : GCFR-Pu/U/Th/Th
Start Up : January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.112	UF ₆ Conversion Services	\$/KgU as UF ₆								
.113	Enrichment Services	\$/SWU								
.114	Depleted U Supply	\$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value	0	0	0	0	0	0	0	0
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH								
.21	Core Fabrication	\$/KgH	842	842	842	842	842	842	842	842
.22	Axial Blanket Fabrication	\$/KgH	79	79	79	79	79	79	79	79
.23	Radial Blanket Fabrication	\$/KgH	207	207	207	207	207	207	207	207
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	94	94	94	94	94	94	94	94
.60	Reprocessing	\$/KgH	370	326	271	260	260	260	260	260
.70	Disposal of Reprocessing Wastes	\$/KgH	194	194	194	194	194	194	194	194
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value	0	0	0	0	0	0	0	0
.90	Refabrication of Recovered Fuel	\$/KgH								

TABLE E1-23b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : GCFR-Pu/U/Th/Th
Start Up : January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	0.89	0.41	0.40	0.40	0.40	0.40	0.40	0.43
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	0.32	0.16	0.16	0.16	0.16	0.16	0.16	0.20 ⁽⁴⁾
.21	Core Fabrication	0.21	0.11	0.11	0.11	0.11	0.11	0.11	
.22	Axial Blanket Fabrication	0.02	0.01	0.01	0.01	0.01	0.01	0.01	
.23	Radial Blanket Fabrication	0.09	0.04	0.04	0.04	0.04	0.04	0.04	
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.09	0.04	0.04	0.04	0.04	0.04	0.04	0.04
.60	Reprocessing	0.48	0.21	0.20	0.20	0.20	0.20	0.20	0.19
.70	Disposal of Reprocessing Wastes }								
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel								

- (1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.
- (2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.
- (3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.
- (4) Includes fabrication of core, axial blanket and radial blanket (account .21, .22 and .23)

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E1-24a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : GCFR-Pu/U/Th/Th
Start Up : January 1, 2001
Bred Fuel Scenario: 2

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	62	63	64	65	66	67	67	68
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
.113	Enrichment Services	\$/SWU	91	91	91	91	91	91	91	91
.114	Depleted U Supply	\$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
.13	U-233 Supply	Parity value	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH								
.21	Core Fabrication	\$/KgH	842	842	842	842	842	842	842	842
.22	Axial Blanket Fabrication	\$/KgH	79	79	79	79	79	79	79	79
.23	Radial Blanket Fabrication	\$/KgH	207	207	207	207	207	207	207	207
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	94	94	94	94	94	94	94	94
.60	Reprocessing	\$/KgH	370	326	271	260	260	260	260	260
.70	Disposal of Reprocessing Wastes	\$/KgH	194	194	194	194	194	194	194	194
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
.83	Bred U-233	Parity value	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17
.90	Refabrication of Recovered Fuel	\$/KgH								

TABLE E1-24b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
No Escalation
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : GCFR-Pu/U/Th/Th
Start Up : January 1, 2001
Bred Fuel Scenario: 2

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu							30-YEAR LEVELIZED TOTAL \$/MBtu
		ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							
		1	5	10	15	20	25	30	
.00	Total	0.69	0.28	0.27	0.27	0.26	0.26	0.27	0.69
.10	Initial Fuel Loaded								
.11	Uranium Supply(1)	-0.59	-0.46	-0.46	-0.46	0.47	-0.47	-0.47	-0.39
.111	U3O8 Supply								
.112	UF6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply(2)	0.39	0.33	0.33	0.33	0.33	0.33	0.33	0.65
.13	U-233 Supply(3)								
.14	Thorium Supply								
.20	Fabrication	0.32	0.16	0.16	0.16	0.16	0.16	0.16	0.20(4)
.21	Core Fabrication	0.21	0.11	0.11	0.11	0.11	0.11	0.11	
.22	Axial Blanket Fabrication	0.02	0.01	0.01	0.01	0.01	0.01	0.01	
.23	Radial Blanket Fabrication	0.09	0.04	0.04	0.04	0.04	0.04	0.04	
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.09	0.04	0.04	0.04	0.04	0.04	0.04	0.04
.60	Reprocessing								
.70	Disposal of Reprocessing Wastes }	0.48	0.21	0.20	0.20	0.20	0.20	0.20	0.19
.80	Final Fuel Recovered (Credits)								
.81	Uranium(1)								
.811	Equivalent U3O8 Supply								
.812	Equivalent UF6 Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium(2)								
.83	Bred U-233(3)								
.90	Refabrication of Recovered Fuel								

- (1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.
- (2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.
- (3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.
- (4) Includes fabrication of core, axial blanket and radial blanket (account .21, .22 and .23).

Note: The 30-Year Levelized Costs Include Indirect Costs

APPENDIX E-2

APPENDIX E-2
INFLATED (6%) FUEL CYCLE COSTS
FOR "THROWAWAY" AND RECYCLE CASES

INDEX OF TABLES

<u>Reactor</u>	<u>Fuel Cycle</u> ^{**}	<u>Bred Fuel + Scenario</u>	<u>Year of Startup</u>	<u>Table Number</u> [*]
PWR	U5(LE)/U-T	N/A	1987	E2-1a/1b
PWR	U5(LE)+Pu(RE)/U	1	1991	E2-2a/2b
HTGR	U5/U/Th-20%-T	N/A	1995	E2-3a/3b
HTGR	U5(DE)/U/Th-20%	None	1995	E2-4a/4b
PHWR	U5(NAT)/U-T	N/A	1995	E2-5a/5b
PHWR	U5(SE)/U-T	N/A	1995	E2-6a/6b
LMFBR	Pu/U/U/U-HT	1	2001	E2-7a/7b
LMFBR	Pu/U/Th/Th-HT	1	2001	E2-8a/8b
GCFR	Pu/U/U/U	1	2001	E2-9a/9b
GCFR	Pu/U/Th/Th	1	2001	E2-10a/10b

* "a" Tables are Input Components
 "b" Tables are Output Components

** See Section 6, Table 6-21

+ See Appendix G

TABLE E2-1a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 6%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : PWR-U5(LE)/U-T
Start Up : January 1, 1987
Bred Fuel Scenario: N/A

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1985	1990	1995	2000	2005	2010	2015	2020
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	68	116	166	230	313	425	578	773
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	7	10	13	17	23	31	42	56
.113	Enrichment Services	\$/SWU	137	189	252	338	452	605	809	1083
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	266	367	491	657	879	1176	1574	2106
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Repository	\$/KgH	27	37	44	59	79	106	142	190
.60	Disposal of Spent Fuel	\$/KgH	201	278	372	497	665	890	1191	1594

TABLE E2-1b
 ENERGY ECONOMIC DATA BASE
 OUTPUT NUCLEAR FUEL COST COMPONENTS
 Escalation at 6%/year
 Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
 System : PWR-U5(LE)/U-T
 Start Up : January 1, 1987
 Bred Fuel Scenario: N/A

Account No.	Account Description	ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR						30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30
.00	Total	1.18	1.23	1.75	2.40	3.23	4.38	5.88
.10	Initial Fuel Loaded							2.35
.11	Uranium Supply	0.81	0.97	1.39	1.92	2.59	3.52	4.73
.111	U ₃ O ₈ Supply							
.112	UF ₆ Conversion Services							
.113	Enrichment Services							
.114	Depleted U Supply							
.12	Plutonium Supply							
.13	U-233 Supply							
.14	Thorium Supply							
.20	Fabrication	0.20	0.14	0.19	0.26	0.34	0.46	0.61
.21	Core Fabrication							0.27
.22	Axial Blanket Fabrication							
.23	Radial Blanket Fabrication							
.30	Shipping to Temporary Storage							
.40	Temporary Storage							
.50	Shipping to Repository	0.02	0.01	0.02	0.02	0.03	0.04	0.06
.60	Disposal of Spent Fuel	0.15	0.11	0.15	0.20	0.27	0.35	0.48

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E2-2a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 6%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : PWR-U5(LE)+Pu(RE)/U
Start Up : January 1, 1991
Bred Fuel Scenario: 1

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1990	1995	2000	2005	2010	2015	2020	2025
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	116	166	230	313	425	578	785	1051
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	10	13	17	23	31	42	56	75
.113	Enrichment Services	\$/SWU	189	252	338	452	605	809	1083	1449
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	367	491	657	879	1176	1574	2106	2818
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	37	44	59	79	106	142	190	255
.60	Reprocessing	\$/KgH	580	688	772	993	1329	1778	2380	3185
.70	Disposal of Reprocessing Wastes	\$/KgH	128	172	230	308	412	551	738	987
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH								
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈	116	166	230	313	425	578	785	1051
.812	Equivalent UF ₆ Conversion Services	\$/KgU	10	13	17	23	31	42	56	75
.813	Equivalent Enrichment Services	\$/SWU	189	252	338	452	605	809	1083	1449
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0.5
.83	Bred U-233	Parity value								
.90	Refabrication of Recovered Fuel	\$/KgH	1007	1347	1803	2413	3229	4321	5783	7739

TABLE E2-2b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 6%/year
Constant January 1, 1978 Dollars

Effective Date January 1, 1978
System PWR-U5(LE)+Pu(RE)/U
Start Up January 1, 1991
Bred Fuel Scenario 1

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu							30-YEAR LEVELIZED TOTAL \$/MBtu
		ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							
		1	5	10	15	20	25	30	
.00	Total	1.90	1.73	2.06	2.72	3.54	4.72	4.65	2.68
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	1.12	1.15	1.26	1.63	2.07	2.74	2.36	1.81
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.00	0.00	0.00	0.00	0.00	0.00	-2.64	-0.04
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication								
.21	Core Fabrication	0.25	0.15	0.16	0.23	0.31	0.38	0.90	0.50 ⁽⁴⁾
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.03	0.02	0.03	0.04	0.05	0.07	0.16	0.02
.60	Reprocessing								
.70	Disposal of Reprocessing Wastes }	0.50	0.34	0.41	0.54	0.73	0.98	2.41	0.39
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel	0.00	0.07	0.20	0.28	0.38	0.55	0.46	(4)

- (1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.
- (2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.
- (3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.
- (4) Levelized fabrication cost under account .20 includes refabrication cost of account .90.

Note The 30-Year Levelized Costs Include Indirect Costs

TABLE E2-3a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 6%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : HTGR-U5/U/Th-20%-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

			INPUT QUANTITIES BY CALENDAR YEAR							
Account No.	Account Description	Units	1990	1995	2000	2005	2010	2015	2020	2025
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	116	166	230	313	425	578	785	1067
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	10	13	17	23	31	42	56	75
.113	Enrichment Services	\$/SWU	189	252	338	452	605	809	1083	1449
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	734	1353	1811	2423	3242	4339	5807	7770
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Repository	\$/KgH	362	499	668	1241	1661	2223	2975	3981
.60	Disposal of Spent Fuel	\$/KgH	745	1026	1373	1837	2458	3290	4403	5892

TABLE E2-3b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 6%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : HTGR-U5/U/Th-20%-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

		OUTPUT QUANTITIES, \$/MBtu						30-YEAR	
		ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR						LEVELIZED	
Account No.	Account Description	1	5	10	15	20	25	30	TOTAL \$/MBtu
.00	Total	2.57	2.05	2.78	3.73	5.07	6.81	9.14	3.93
.10	Initial Fuel Loaded								
.11	Uranium Supply	1.85	1.72	2.34	3.13	4.27	5.72	7.72	3.42
.111	U3O8 Supply								
.112	UF6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.28	0.14	0.19	0.25	0.33	0.47	0.61	0.30
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.15	0.08	0.11	0.15	0.21	0.27	0.36	0.09
.60	Disposal of Spent Fuel	0.29	0.11	0.14	0.20	0.26	0.35	0.45	0.12

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E2-4a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 6%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : HTGR-U5 (DE)/U/Th-20%
Start Up : January 1, 1995
Bred Fuel Scenario: None

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1990	1995	2000	2005	2010	2015	2020	2025
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	116	166	230	313	425	578	785	1067
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	10	13	17	23	31	42	56	75
.113	Enrichment Services	\$/SWU	189	252	338	452	605	809	1083	1449
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value	0	0	0	0	0	0	0	0
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	734	1353	1811	2423	3242	4339	5807	7770
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	362	499	668	1241	1661	2223	2975	3981
.60	Reprocessing	\$/KgH	1075	1439	2671	3575	4784	6402	8567	11465
.70	Disposal of Reprocessing Wastes	\$/KgH	242	324	434	581	777	1040	1392	1863
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value	0	0	0	0	0	0	0	1.17
.90	Refabrication of Recovered Fuel	\$/KgH	2842	3917	5241	7014	9386	12561	16809	22495

TABLE E2-4b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 6%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System: HTGR-U5 (DE)/U/Th-20%
Start Up: January 1, 1995
Bred Fuel Scenario: None

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	2.76	1.93	2.74	3.64	4.97	6.56	15.43	3.72
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	1.85	1.39	2.02	2.69	3.69	4.80	11.36	2.98
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	0.25	0.13	0.16	0.21	0.29	0.39	0.95	0.37 ⁽⁴⁾
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.15	0.09	0.12	0.16	0.22	0.30	0.64	0.09
.60	Reprocessing								
.70	Disposal of Reprocessing Wastes }	0.51	0.26	0.36	0.47	0.63	0.87	2.01	0.28
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel	0.00	0.06	0.08	0.11	0.14	0.20	0.47	(4)

- (1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.
- (2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.
- (3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.
- (4) Levelized fabrication cost under account .20 includes refabrication cost of account .90.

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E2-5a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 6%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : CANDU U5(NAT)/U-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1990	1995	2000	2005	2010	2015	2020	2025
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	116	166	230	313	425	578	785	1067
.112	UF ₆ Conversion Services	\$/KgU as UF ₆								
.113	Enrichment Services	\$/SWU								
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	209	288	386	516	691	925	1237	1656
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Repository	\$/KgH	26	33	45	60	80	107	143	191
.60	Disposal of Spent Fuel	\$/KgH	167	230	308	412	551	738	988	1322

TABLE E2-5b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 6%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : CANDU-U5(NAT)/U-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	2.73	2.51	3.45	4.65	6.06	8.30	10.96	3.93
.10	Initial Fuel Loaded								
.11	Uranium Supply	1.23	1.16	1.61	2.11	2.87	3.96	5.46	1.91
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.80	0.71	0.97	1.37	1.68	2.29	3.11	1.15
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.09	0.08	0.11	0.15	0.19	0.26	0.30	0.11
.60	Disposal of Spent Fuel	0.61	0.56	0.76	1.02	1.32	1.79	2.09	0.76

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E2-6a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 6%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : CANDU-U5 (SE)/U-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1990	1995	2000	2005	2010	2015	2020	2025
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	116	166	230	313	425	578	785	1067
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	10	13	17	23	31	42	56	75
.113	Enrichment Services	\$/SWU	189	252	338	452	605	809	1083	1449
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	209	288	386	516	691	925	1237	1656
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Repository	\$/KgH	26	33	45	60	80	107	143	191
.60	Disposal of Spent Fuel	\$/KgH	167	230	308	412	551	738	988	1322

TABLE E2-6b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 6%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : CANDU-U5(SE)/U-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	1.67	1.19	1.64	2.23	2.99	3.98	5.27	2.11
.10	Initial Fuel Loaded								
.11	Uranium Supply	0.80	0.77	1.08	1.47	2.02	2.65	3.63	1.46
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.46	0.21	0.28	0.38	0.49	0.67	0.91	0.40
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.05	0.03	0.04	0.05	0.06	0.08	0.09	0.03
.60	Disposal of Spent Fuel	0.36	0.18	0.24	0.33	0.42	0.58	0.64	0.22

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E2-7a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 6%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : LMFBR-Pu/U/U/U-HT
Start Up : January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.112	UF ₆ Conversion Services	\$/KgU as UF ₆								
.113	Enrichment Services	\$/SWU								
.114	Depleted U Supply	\$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH								
.21	Core Fabrication	\$/KgH	2853	3818	5109	6837	9150	12245	15459	21929
.22	Axial Blanket Fabrication	\$/KgH	182	243	326	436	583	780	1044	1397
.23	Radial Blanket Fabrication	\$/KgH	657	879	1176	1574	2106	2818	3772	5047
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	349	467	625	836	1118	1497	1890	2681
.60	Reprocessing	\$/KgH	1372	1619	1801	2312	3094	4140	5540	7414
.70	Disposal of Reprocessing Wastes	\$/KgH	720	963	1289	1725	2308	3089	4134	5532
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value								
.90	Refabrication of Recovered Fuel	\$/KgH								

TABLE E2-7b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 6%/year
Constant January 1, 1978 Dollars

Effective Date January 1, 1978
System LMFBR-Pu/U/U/U-HT
Start Up January 1, 2001
Bred Fuel Scenario 1

Account No.	Account Description	OUTPUT QUANTITIES, \$/Mbtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/Mbtu
		1	5	10	15	20	25	30	
.00	Total	2.84	1.95	2.45	3.37	4.45	5.96	8.03	2.73
10	Initial Fuel Loaded								
11	Uranium Supply ⁽¹⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
113	Enrichment Services								
114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.13	U-233 Supply ⁽³⁾								
14	Thorium Supply								
20	Fabrication	0.97	0.74	0.93	1.30	1.77	2.29	3.12	1.32 ⁽⁴⁾
21	Core Fabrication	0.75	0.62	0.80	1.10	1.50	1.93	2.64	
.22	Axial Blanket Fabrication	0.04	0.03	0.02	0.06	0.07	0.10	0.13	
.23	Radial Blanket Fabrication	0.17	0.09	0.11	0.14	0.20	0.26	0.35	
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.29	0.20	0.28	0.33	0.49	0.67	0.89	0.25
.60	Reprocessing								
.70	Disposal of Reprocessing Wastes }	1.58	1.01	1.24	1.69	2.19	3.00	4.02	1.16
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel								

(1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.

(2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.

(3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.

(4) Includes fabrication of core, axial blanket and radial blanket (account .21, .22 and .23).

Note The 30-Year Levelized Costs Include Indirect Costs

TABLE E2-8a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 6%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : LMFBR-Fu/U/Th/Th-HT
Start Up : January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.112	UF ₆ Conversion Services	\$/KgU as UF ₆								
.113	Enrichment Services	\$/SWU								
.114	Depleted U-Supply	\$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value	0	0	0	0	0	0	0	0
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH								
.21	Core Fabrication	\$/KgH	2853	3818	5109	6837	9150	12245	15459	21929
.22	Axial Blanket Fabrication	\$/KgH	293	392	525	702	940	1258	1683	2253
.23	Radial Blanket Fabrication	\$/KgH	768	1028	1375	1841	2463	3296	4411	5903
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	349	467	625	836	1118	1497	1890	2681
.60	Reprocessing	\$/KgH	1372	1619	1801	2312	3094	4140	5540	7414
.70	Disposal of Reprocessing Wastes	\$/KgH	720	963	1289	1725	2308	3089	4134	5532
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value	0	0	0	0	0	0	0	0
.90	Refabrication of Recovered Fuel	\$/KgH								

TABLE E2-8b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 6%/year
Constant January 1, 1978 Dollars

Effective Date January 1, 1978
System LMFBR-Pu/U/Th/Th-HT
Start Up January 1, 2001
Bred Fuel Scenario 1

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	3.66	2.38	3.07	4.12	5.51	7.37	10.02	3.40
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	1.35	0.93	1.25	1.68	2.25	3.00	4.06	1.70 ⁽⁴⁾
.21	Core Fabrication	1.05	0.78	1.05	1.40	1.87	2.51	3.35	
.22	Axial Blanket Fabrication	0.08	0.05	0.07	0.10	0.14	0.17	0.24	
.23	Radial Blanket Fabrication	0.22	0.10	0.13	0.18	0.24	0.32	0.47	
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.35	0.24	0.32	0.43	0.57	0.77	1.05	0.29
.60	Reprocessing								
.70	Disposal of Reprocessing Wastes }	1.96	1.21	1.50	2.01	2.69	3.60	4.91	1.41
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel								

(1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.

(2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.

(3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.

(4) Includes fabrication of core, axial blanket and radial blanket (account .21, .22 and .23)

Note The 30-Year Levelized Costs Include Indirect Costs

TABLE E2-9a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 6%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : GCFR-Pu/U/U/U
Start Up : January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.112	UF ₆ Conversion Services	\$/KgU as UF ₆								
.113	Enrichment Services	\$/SWU								
.114	Depleted U-Supply	\$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH								
.21	Core Fabrication	\$/KgH	3124	4180	5594	7487	10019	13407	17942	24010
.22	Axial Blanket Fabrication	\$/KgH	182	243	326	436	583	780	1044	1397
.23	Radial Blanket Fabrication	\$/KgH	657	879	1176	1574	2106	2818	3772	5047
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	349	467	625	836	1118	1497	1890	2681
.60	Reprocessing	\$/KgH	1372	1619	1801	2312	3094	4140	5540	7414
.70	Disposal of Reprocessing Wastes	\$/KgH	720	963	1289	1725	2308	3089	4134	5532
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value								
.90	Refabrication of Recovered Fuel	\$/KgH								

TABLE E2-9b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 6%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : GCFR-Pu/U/U/U
Start Up : January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	3.96	2.31	2.94	3.89	5.27	7.04	9.42	3.07
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	1.17	0.70	0.93	1.24	1.67	2.23	2.98	(4)
.21	Core Fabrication	0.76	0.50	0.67	0.89	1.20	1.60	2.14	1.44
.22	Axial Blanket Fabrication	0.07	0.04	0.02	0.06	0.08	0.11	0.15	
.23	Radial Blanket Fabrication	0.34	0.16	0.22	0.29	0.39	0.52	0.69	
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.42	0.26	0.35	0.46	0.63	0.84	1.13	0.27
.60	Reprocessing	2.37	1.35	1.66	2.19	2.97	3.97	5.31	1.36
.70	Disposal of Reprocessing Wastes }								
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel								

(1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.

(2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.

(3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.

(4) Includes fabrication of core, axial blanket and radial blanket (account .21, .22 and .23).

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E2-10a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 6%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : GCFR-Pu/U/Th/Th
Start Up : January 1, 2001
Bred Fuel Scenario: 1

			INPUT QUANTITIES BY CALENDAR YEAR							
Account No.	Account Description	Units	2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.112	UF ₆ Conversion Services	\$/KgU as UF ₆								
.113	Enrichment Services	\$/SWU								
.114	Depleted U Supply	\$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value	0	0	0	0	0	0	0	0
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH								
.21	Core Fabrication	\$/KgH	3124	4180	5594	7487	10019	13407	17942	24010
.22	Axial Blanket Fabrication	\$/KgH	293	392	525	702	940	1258	1683	2253
.23	Radial Blanket Fabrication	\$/KgH	768	1028	1375	1841	2463	3296	4441	5903
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	349	467	625	836	1118	1497	1890	2681
.60	Reprocessing	\$/KgH	1372	1619	1801	2312	3094	4140	5540	7414
.70	Disposal of Reprocessing Wastes	\$/KgH	720	963	1289	1725	2308	3089	4134	5532
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value	0	0	0	0	0	0	0	0
.90	Refabrication of Recovered Fuel	\$/KgH								

TABLE E2-10b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 6%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : GCFR-Pu/U/Th/Th
Start Up : January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	3.66	2.16	2.76	3.64	4.93	6.58	8.80	2.93
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	1.19	0.71	0.95	1.26	1.70	2.27	3.04	1.46 ⁽⁴⁾
.21	Core Fabrication	0.77	0.50	0.67	0.89	1.20	1.60	2.14	
.22	Axial Blanket Fabrication	0.07	0.04	0.06	0.08	0.11	0.14	0.20	
.23	Radial Blanket Fabrication	0.35	0.17	0.22	0.29	0.39	0.53	0.70	
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.37	0.24	0.32	0.42	0.57	0.76	1.01	0.25
.60	Reprocessing								
.70	Disposal of Reprocessing Wastes }	2.10	1.21	1.49	1.96	2.66	3.55	4.75	1.22
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel								

- (1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.
- (2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.
- (3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.
- (4) Includes fabrication of core, axial blanket and radial blanket (account .21, .22 and .23).

Note: The 30-Year Levelized Costs Include Indirect Costs

APPENDIX E-3

APPENDIX E-3

INFLATED (7%) FUEL CYCLE COSTS
FOR "THROWAWAY" AND RECYCLE CASES

INDEX OF TABLES

<u>Reactor</u>	<u>Fuel Cycle</u> **	<u>Bred Fuel</u> ⁺ <u>Scenario</u>	<u>Year of</u> <u>Startup</u>	<u>Table Number</u> *
PWR	U5(LE)/U-T	N/A	1987	E3-1a/1b
PWR	U5(LE)+Pu(RE)/U	1	1991	E3-2a/2b
HTGR	U5/U/Th-20%-T	N/A	1995	E3-3a/3b
HTGR	U5(DE)/U/Th-20%	None	1995	E3-4a/4b
PHWR	U5(NAT)/U-T	N/A	1995	E3-5a/5b
PHWR	U5(SE)/U-T	N/A	1995	E3-6a/6b
LMFBR	Pu/U/U/U-HT	1	2001	E3-7a/7b
LMFBR	Pu/U/Th/Th-HT	1	2001	E3-8a/8b
GCFR	Pu/U/U/U	1	2001	E3-9a/9b
GCFR	Pu/U/Th/Th	1	2001	E3-10a/10b

* "a" Tables are Input Components

"b" Tables are Output Components

** See Section 6, Table 6-21

+ See Appendix G

TABLE E3-1a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 7%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : PWR-U5(LE)/U-T
Start Up : January 1, 1987
Bred Fuel Scenario: N/A

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1985	1990	1995	2000	2005	2010	2015	2020
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	72	130	196	284	405	577	822	1153
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	8	11	15	22	30	42	59	83
.113	Enrichment Services	\$/SWU	146	212	297	417	585	820	1151	1614
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	284	412	578	811	1138	1596	2238	3139
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Repository	\$/KgH	29	42	52	73	103	144	202	284
.60	Disposal of Spent Fuel	\$/KgH	215	312	438	614	861	1208	1694	2376

TABLE E3-1b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 7%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : PWR-U5 (LE) U-T
Start Up : January 1, 1987
Bred Fuel Scenario: N/A

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	1.28	1.39	2.04	2.94	4.16	5.92	8.32	2.82
.10	Initial Fuel Loaded								
.11	Uranium Supply	0.88	1.08	1.62	2.34	3.32	4.73	6.66	2.31
.111	U3O8 Supply								
.112	UF6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.21	0.16	0.22	0.31	0.44	0.62	0.86	0.33
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.02	0.02	0.02	0.03	0.04	0.06	0.09	0.02
.60	Disposal of Spent Fuel	0.17	0.13	0.18	0.26	0.36	0.51	0.71	0.16

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E3-2a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 7%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : PWR-U5 (LE)+Pu (RE)/U
Start Up : January 1, 1991
Bred Fuel Scenario: 1

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1990	1995	2000	2005	2010	2015	2020	2025
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	130	196	284	405	577	822	1153	1642
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	11	15	22	30	42	59	83	117
.113	Enrichment Services	\$/SWU	212	297	417	585	820	1151	1614	2263
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	412	578	811	1138	1596	2238	3139	4403
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	42	52	73/91 ⁽¹⁾	103/129	144/180	202/253	284/355	398/497
.60	Reprocessing	\$/KgH	652	810	953	1286	1803	2529	3547	4975
.70	Disposal of Reprocessing Wastes	\$/KgH	144	203	284	398	559	784	1100	1542
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH								
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈	130	196	284	405	577	822	1153	1642
.812	Equivalent UF ₆ Conversion Services	\$/KgU	11	15	22	30	42	59	83	117
.813	Equivalent Enrichment Services	\$/SWU	212	297	417	585	820	1151	1614	2263
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0.5
.83	Bred U-233	Parity value								
.90	Refabrication of Recovered Fuel	\$/KgH	1132	1588	2227	3124	4381	6145	8619	12088

(1) makeup fuel/recycle fuel

TABLE E3-2b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 7%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : PWR-U5(LE)+Pu(RE)/U
Start Up : January 1, 1991
Bred Fuel Scenario: 1

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	2.15	2.02	2.50	3.50	4.75	6.64	6.72	3.32
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	1.27	1.33	1.54	2.08	2.76	3.83	3.34	2.26
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.00	0.00	0.00	0.00	0.00	0.00	-3.95	-0.06
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	0.28	0.17	0.20	0.30	0.42	0.59	1.32	0.62 ⁽⁴⁾
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.03	0.02	0.03	0.05	0.07	0.10	0.24	0.03
.60	Reprocessing								
.70	Disposal of Reprocessing Wastes }	0.57	0.41	0.51	0.72	1.00	1.41	3.62	0.47
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel	0.00	0.09	0.22	0.35	0.50	0.71	2.15	(4)

(1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.

(2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.

(3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.

(4) Levelized fabrication cost under account .20 includes refabrication cost of account .90.

Note. The 30-Year Levelized Costs Include Indirect Costs

TABLE E3-3a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 7%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : HTGR-U5/U/Th-20%-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1990	1995	2000	2005	2010	2015	2020	2025
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	130	196	284	405	577	822	1153	1667
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	11	15	22	30	42	59	83	117
.113	Enrichment Services	\$/SWU	212	297	417	585	820	1151	1614	2263
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	822	1595	2236	3137	4399	6170	8654	12138
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Repository	\$/KgH	419	588	1146	1607	2254	3161	4434	6218
.60	Disposal of Spent Fuel	\$/KgH	833	1209	1696	2378	3336	4678	6562	9203

TABLE E3-3b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 7%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : HTGR-U5/U/Th-20%-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	3.03	2.48	3.52	4.97	7.08	9.93	13.95	5.08
.10	Initial Fuel Loaded								
.11	Uranium Supply	2.18	2.07	2.94	4.13	5.92	8.30	11.72	4.43
.111	U3O8 Supply								
.112	UF6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.32	0.16	0.24	0.34	0.46	0.68	0.93	0.39
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.18	0.11	0.15	0.22	0.31	0.42	0.57	0.10
.60	Disposal of Spent Fuel	0.35	0.14	0.19	0.28	0.39	0.53	0.73	0.16

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E3-4a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 7%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : HTGR-U5(DE)/U/Th-20%
Start Up : January 1, 1995
Bred Fuel Scenario: None

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1990	1995	2000	2005	2010	2015	2020	2025
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	130	196	284	405	577	822	1153	1667
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	11	15	22	30	42	59	83	117
.113	Enrichment Services	\$/SWU	212	297	417	585	820	1151	1614	2263
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value	0	0	0	0	0	0	0	0
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	822	1595	2236	3137	4399	6170	8654	12138
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	419	588	1146	1607	2254	3161	4434	6218
.60	Reprocessing	\$/KgH	1209	2353	3300	4628	6491	9104	12769	17909
.70	Disposal of Reprocessing Wastes	\$/KgH	273	382	536	752	1055	1479	2075	2910
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value	0	0	0	0	0	0	0	0
.90	Refabrication of Recovered Fuel	\$/KgH	3331	4616	6474	9080	12736	17862	25053	35138

TABLE E3-4b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 7%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System HTGR-U5 (DE)/U/Th-20%
Start Up January 1, 1995
Bred Fuel Scenario None

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	3.27	2.33	3.49	4.85	6.94	9.57	23.55	4.80
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	2.18	1.67	2.55	3.55	5.12	6.95	17.27	3.86
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	0.30	0.15	0.21	0.28	0.39	0.57	1.44	0.47 ⁽⁴⁾
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.18	0.11	0.16	0.23	0.32	0.46	0.99	0.12
.60	Reprocessing								
.70	Disposal of Reprocessing Wastes }	0.61	0.33	0.47	0.65	0.91	1.31	3.13	0.35
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel	0.00	0.07	0.10	0.14	0.20	0.28	0.72	(4)

(1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.

(2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.

(3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.

(4) Levelized fabrication cost under account .20 includes refabrication cost of account .90.

Note The 30-Year Levelized Costs Include Indirect Costs

TABLE E3-5a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 7%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : CANDU U5(NAT)/U-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1990	1995	2000	2005	2010	2015	2020	2025
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	133	196	284	405	577	822	1170	1667
.112	UF ₆ Conversion Services	\$/KgU as UF ₆								
.113	Enrichment Services	\$/SWU								
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	235	340	477	668	938	1315	1844	2587
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Repository	\$/KgH	29	39	55	77	108	152	213	298
.60	Disposal of Spent Fuel	\$/KgH	187	271	380	534	748	1049	1472	2064

TABLE E3-5b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 7%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : CANDU-U5(NAT)/U-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

		OUTPUT QUANTITIES, \$/MBtu							30-YEAR
		ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							LEVELIZED
<u>Account No.</u>	<u>Account Description</u>	<u>1</u>	<u>5</u>	<u>10</u>	<u>15</u>	<u>20</u>	<u>25</u>	<u>30</u>	<u>TOTAL \$/MBtu</u>
.00	Total	3.25	3.11	4.48	6.24	8.61	12.38	17.07	5.13
.10	Initial Fuel Loaded								
.11	Uranium Supply	1.44	1.42	2.06	2.81	4.02	5.83	8.43	2.46
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.94	0.87	1.24	1.76	2.35	3.36	4.79	1.48
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.11	0.10	0.15	0.21	0.28	0.40	0.49	0.15
.60	Disposal of Spent Fuel	0.76	0.72	1.03	1.46	1.96	2.79	3.36	1.04

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E3-6a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 7%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : CANDU-U5(SE)/U-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1990	1995	2000	2005	2010	2015	2020	2025
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	133	196	284	405	577	822	1170	1667
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	11	15	22	30	42	59	83	117
.113	Enrichment Services	\$/SWU	212	297	417	585	820	1151	1614	2263
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	235	340	477	668	938	1315	1844	2587
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Repository	\$/KgH	29	39	55	77	108	152	213	298
.60	Disposal of Spent Fuel	\$/KgH	187	271	380	534	748	1049	1472	2064

TABLE E3-6b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 7%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : CANDU-U5(SE)/U-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

		OUTPUT QUANTITIES, \$/MBtu							30-YEAR
		ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							LEVELIZED
<u>Account No.</u>	<u>Account Description</u>	<u>1</u>	<u>5</u>	<u>10</u>	<u>15</u>	<u>20</u>	<u>25</u>	<u>30</u>	<u>TOTAL \$/MBtu</u>
.00	Total	2.00	1.44	2.11	3.01	4.22	5.86	8.09	2.74
.10	Initial Fuel Loaded								
.11	Uranium Supply	0.94	0.93	1.36	1.95	2.81	3.85	5.53	1.89
.111	U3O8 Supply								
.112	UF6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.54	0.25	0.36	0.51	0.68	0.97	1.39	0.52
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.07	0.03	0.05	0.07	0.09	0.13	0.15	0.04
.60	Disposal of Spent Fuel	0.45	0.23	0.34	0.48	0.64	0.91	1.02	0.29

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E3-7a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 7%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : LMFBR-Pu/U/U/U-HT
Start Up : January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.112	UF ₆ Conversion Services	\$/KgU as UF ₆								
.113	Enrichment Services	\$/SWU								
.114	Depleted U Supply	\$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH								
.21	Core Fabrication	\$/KgH	3524	4942	6933	9723	13638	19127	26827	37626
.22	Axial Blanket Fabrication	\$/KgH	225	315	442	620	869	1219	1709	2398
.23	Radial Blanket Fabrication	\$/KgH	811	1138	1596	2238	3139	4403	6175	8660
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	431	604	847	1189	1667	2338	3279	4599
.60	Reprocessing	\$/KgH	1696	2095	2443	3287	4611	6467	9070	12722
.70	Disposal of Reprocessing Wastes	\$/KgH	889	1247	1749	2453	3440	4825	6768	9492
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value								
.90	Refabrication of Recovered Fuel	\$/KgH								

TABLE E3-7b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 7%/year
Constant January 1, 1978 Dollars

Effective Date January 1, 1978
System LMFBR-Pu/U/U-U-HT
Start Up January 1, 2001
Bred Fuel Scenario 1

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	3.55	2.54	3.36	4.81	6.67	9.36	13.23	3.70
10	Initial Fuel Loaded								
11	Uranium Supply ⁽¹⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
111	U ₃ O ₈ Supply								
112	UF ₆ Conversion Services								
113	Enrichment Services								
.114	Depleted U Supply								
12	Plutonium Supply ⁽²⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	U-233 Supply ⁽³⁾								
14	Thorium Supply								
20	Fabrication	1.20	0.95	1.27	1.83	2.62	3.53	5.06	1.81 ⁽⁴⁾
.21	Core Fabrication	0.94	0.80	1.07	1.54	2.22	2.98	4.29	
.22	Axial Blanket Fabrication	0.04	0.04	0.06	0.09	0.11	0.16	0.22	
23	Radial Blanket Fabrication	0.22	0.11	0.14	0.20	0.29	0.39	0.55	
30	Shipping to Temporary Storage								
40	Temporary Storage								
.50	Shipping to Reprocessor	0.36	0.27	0.38	0.54	0.74	1.06	1.49	0.33
.60	Reprocessing	1.99	1.32	1.71	2.44	3.31	4.77	6.68	1.56
.70	Disposal of Reprocessing Wastes								
80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel								

(1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.

(2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.

(3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account 13 less account .83) is included in account .11, Uranium Supply.

(4) Includes fabrication of core, axial blanket and radial blanket (account .21, .22 and .23).

Note The 30-Year Levelized Costs Include Indirect Costs

TABLE E3-8a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 7%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : LMFBR-Pu/U/Th/Th-HT
Start Up : January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.112	UF ₆ Conversion Services	\$/KgU as UF ₆								
.113	Enrichment Services	\$/SWU								
.114	Depleted U Supply	\$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value	0	0	0	0	0	0	0	0
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH								
.21	Core Fabrication	\$/KgH	3524	4942	6933	9723	13638	19127	26827	37626
.22	Axial Blanket Fabrication	\$/KgH	362	508	712	999	1401	1965	2756	3865
.23	Radial Blanket Fabrication	\$/KgH	949	1331	1866	2617	3671	5149	7221	10128
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	431	604	847	1189	1667	2338	3279	4599
.60	Reprocessing	\$/KgH	1696	2095	2443	3287	4611	6467	9070	12722
.70	Disposal of Reprocessing Wastes	\$/KgH	889	1247	1749	2453	3440	4825	6768	9492
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value	0	0	0	0	0	0	0	0
.90	Refabrication of Recovered Fuel	\$/KgH								

TABLE E3-8b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 7%/year
Constant January 1, 1978 Dollars

Effective Date January 1, 1978
System LMFBR-Pu/U/Th/Th-HT
Start Up January 1, 2001
Bred Fuel Scenario 1

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	4.59	3.10	4.19	5.89	8.25	11.58	16.51	4.63
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	1.67	1.19	1.68	2.36	3.31	4.64	6.57	
.21	Core Fabrication	1.31	1.00	1.41	1.97	2.77	3.88	5.44	
.22	Axial Blanket Fabrication	0.09	0.06	0.09	0.14	0.19	0.27	0.38	
.23	Radial Blanket Fabrication	0.27	0.13	0.18	0.25	0.35	0.49	0.75	
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.44	0.31	0.44	0.62	0.87	1.22	1.75	
.60	Reprocessing								
.70	Disposal of Reprocessing Wastes	2.48	1.60	2.07	2.91	4.07	5.72	8.19	
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel								

(1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.

(2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.

(3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.

(4) Includes fabrication of core, axial blanket and radial blanket (account .21, .22 and .23).

Note The 30-Year Levelized Costs Include Indirect Costs

TABLE E3-9a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 7%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : GCFR-Pu/U/U/U
Start Up : January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.112	UF ₆ Conversion Services	\$/KgU as UF ₆								
.113	Enrichment Services	\$/SWU								
.114	Depleted U Supply	\$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH								
.21	Core Fabrication	\$/KgH	3859	5412	7591	10646	14932	20943	29374	41198
.22	Axial Blanket Fabrication	\$/KgH	225	315	442	620	869	1219	1709	2398
.23	Radial Blanket Fabrication	\$/KgH	811	1138	1596	2238	3139	4403	6175	8660
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	431	604	847	1189	1667	2338	3279	4599
.60	Reprocessing	\$/KgH	1696	2095	2443	3287	4611	6467	9070	12722
.70	Disposal of Reprocessing Wastes	\$/KgH	889	1247	1749	2453	3440	4825	6768	9492
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value								
.90	Refabrication of Recovered Fuel	\$/KgH								

TABLE E3-9b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 7%/year
Constant January 1, 1978 Dollars

Effective Date January 1, 1978
System GCFR-Pu/U/U/U
Start Up January 1, 2001
Bred Fuel Scenario 1

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	4.97	3.02	4.04	5.59	7.94	11.10	15.58	4.15
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	1.44	0.89	1.24	1.73	2.44	3.41	4.79	1.96 ⁽⁴⁾
.21	Core Fabrication	0.95	0.64	0.89	1.25	1.76	2.46	3.45	
.22	Axial Blanket Fabrication	0.06	0.04	0.06	0.08	0.12	0.16	0.24	
.23	Radial Blanket Fabrication	0.43	0.21	0.29	0.40	0.56	0.79	0.10	
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.53	0.35	0.49	0.68	0.96	1.35	1.89	0.37
.60	Reprocessing								
.70	Disposal of Reprocessing Wastes	3.00	1.78	2.31	3.18	4.54	6.34	8.90	1.82
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel								

- (1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.
- (2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.
- (3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.
- (4) Includes fabrication of core, axial blanket and radial blanket (account .21, .22 and .23).

Note The 30-Year Levelized Costs Include Indirect Costs

TABLE E3-10a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 7%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : GCPR-Pu/U/Th/Th
Start Up : January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.112	UF ₆ Conversion Services	\$/KgU as UF ₆								
.113	Enrichment Services	\$/SWU								
.114	Depleted U Supply	\$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value	0	0	0	0	0	0	0	0
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH								
.21	Core Fabrication	\$/KgH	3859	5412	7591	10646	14932	20943	29374	41198
.22	Axial Blanket Fabrication	\$/KgH	362	508	712	999	1401	1965	2756	3865
.23	Radial Blanket Fabrication	\$/KgH	949	1331	1866	2617	3671	5149	7221	10128
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	431	604	847	1187	1667	2338	3279	4599
.60	Reprocessing	\$/KgH	1696	2095	2443	3287	4611	6467	9070	12722
.70	Disposal of Reprocessing Wastes	\$/KgH	889	1247	1749	2453	3440	4825	6768	9492
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value	0	0	0	0	0	0	0	0
.90	Refabrication of Recovered Fuel	\$/KgH								

TABLE E3-10b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 7%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : GCFR-Pu/U/Th/Th
Start Up : January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	4.61	2.82	3.77	5.22	7.40	10.36	14.53	3.96
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	1.48	0.91	1.26	1.76	2.48	3.48	4.88	2.00 ⁽⁴⁾
.21	Core Fabrication	0.95	0.64	0.89	1.25	1.75	2.46	3.45	
.22	Axial Blanket Fabrication	0.10	0.06	0.08	0.11	0.16	0.23	0.32	
.23	Radial Blanket Fabrication	0.43	0.21	0.29	0.40	0.57	0.79	1.11	
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.47	0.31	0.44	0.61	0.86	1.21	1.69	0.33
.60	Reprocessing								
.70	Disposal of Reprocessing Wastes }	2.66	1.60	2.07	2.85	4.06	5.67	7.96	1.63
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel								

- (1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.
- (2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.
- (3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.
- (4) Includes fabrication of core, axial blanket and radial blanket (account .21, .22 and .23)
Note: The 30-Year Levelized Costs Include Indirect Costs

APPENDIX E-4

APPENDIX E-4

INFLATED (8%) FUEL CYCLE COSTS
FOR "THROWAWAY" AND RECYCLE CASES

INDEX OF TABLES

<u>Reactor</u>	<u>Fuel Cycle</u> ^{**}	<u>Bred Fuel</u> ⁺ <u>Scenario</u>	<u>Year of</u> <u>Startup</u>	<u>Table Number</u> [*]
PWR	U5(LE)/U-T	N/A	1987	E4-1a/1b
PWR	U5(LE)+Pu(RE)/U	1	1991	E4-2a/2b
HTGR	U5/U/Th-20%-T	N/A	1995	E4-3a/3b
HTGR	U5(DE)/U/Th-20%	None	1995	E4-4a/4b
PHWR	U5(NAT)/U-T	N/A	1995	E4-5a/5b
PHWR	U5(SE)/U-T	N/A	1995	E4-6a/6b
LMFBR	Pu/U/U/U-HT	1	2001	E4-7a/7b
LMFBR	Pu/U/Th/Th-HT	1	2001	E4-8a/8b
GCFR	Pu/U/U/U	1	2001	E4-9a/9b
GCFR	Pu/U/Th/Th	1	2001	E4-10a/10b

* "a" Tables are Input Components

"b" Tables are Output Components

** See Section 6, Table 6-21

+ See Appendix G

TABLE E4-1a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 8%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : PWR-U5 (LE)/U-T
Start Up : January 1, 1987
Bred Fuel Scenario: N/A

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1985	1990	1995	2000	2005	2010	2015	2020
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	77	147	231	350	523	781	1165	1712
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	8	12	18	27	39	57	84	124
.113	Enrichment Services	\$/SWU	156	238	350	514	755	1110	1631	2396
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	303	463	681	1000	1469	2159	3172	4661
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Repository	\$/KgH	31	47	62	90	133	195	287	421
.60	Disposal of Spent Fuel	\$/KgH	230	351	515	757	1112	1634	2402	3529

TABLE E4-1b
 ENERGY ECONOMIC DATA BASE
 OUTPUT NUCLEAR FUEL COST COMPONENTS
 Escalation at 8%/year
 Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
 System : PWR-U5(LE)/U-T
 Start Up : January 1, 1987
 Bred Fuel Scenario: N/A

		OUTPUT QUANTITIES, \$/MBtu							30-YEAR
		ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							LEVELIZED
Account No.	Account Description	1	5	10	15	20	25	30	TOTAL \$/MBtu
.00	Total	1.41	1.56	2.41	3.61	5.36	7.99	11.77	3.36
.10	Initial Fuel Loaded								
.11	Uranium Supply	0.96	1.21	1.89	2.86	4.25	6.35	9.36	2.76
.111	U3O8 Supply								
.112	UF6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.23	0.18	0.26	0.38	0.56	0.83	1.22	0.39
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.03	0.02	0.03	0.04	0.06	0.09	0.13	0.02
.60	Disposal of Spent Fuel	0.19	0.15	0.23	0.33	0.49	0.72	1.06	0.19

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E4-2a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 8%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : PWR-U5(LE)+Pu(RE)/U
Start Up : January 1, 1991
Bred Fuel Scenario: 1

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1990	1995	2000	2005	2010	2015	2020	2025
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	147	231	350	523	781	1165	1738	2554
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	12	18	27	39	57	84	124	182
.113	Enrichment Services	\$/SWU	238	350	514	755	1110	1631	2396	3521
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	463	681	1000	1469	2159	3172	4661	6849
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	47	62	90	133	195	287	421	619
.60	Reprocessing	\$/KgH	733	954	1175	1660	2440	3584	5267	7739
.70	Disposal of Reprocessing Wastes	\$/KgH	162	238	350	515	756	1111	1633	2399
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH								
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈	147	231	350	523	781	1165	1738	2554
.812	Equivalent UF ₆ Conversion Services	\$/KgU	12	18	27	39	57	84	124	182
.813	Equivalent Enrichment Services	\$/SWU	238	350	514	755	1110	1631	2396	3521
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0.5
.83	Bred U-233	Parity value								
.90	Refabrication of Recovered Fuel	\$/KgH	1272	1869	2746	4035	5928	8710	12798	18805

TABLE E4-2b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 8%/year
Constant January 1, 1978 Dollars

Effective Date January 1, 1978
System PWR-U5 (LE)+Pu (RE)/U
Start Up January 1, 1991
Bred Fuel Scenario 1

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	2.44	2.37	3.09	4.49	6.38	9.31	9.65	4.11
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	1.43	1.55	1.88	2.67	3.68	5.34	4.71	2.80
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.00	0.00	0.00	0.00	0.00	-0.01	-5.89	-0.07
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	0.32	0.20	0.24	0.37	0.56	0.75	1.94	0.77 ⁽⁴⁾
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.04	0.03	0.04	0.06	0.09	0.14	0.35	0.04
.60	Reprocessing								
.70	Disposal of Reprocessing Wastes }	0.65	0.49	0.64	0.94	1.38	2.03	5.40	0.57
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel	0.00	0.10	0.29	0.45	0.67	1.06	3.14	(4)

- (1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.
- (2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.
- (3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.
- (4) Levelized fabrication cost under account .20 includes refabrication cost of account .90.

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E4-3a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 8%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : HTGR-US/U/Th-20%-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1990	1995	2000	2005	2010	2015	2020	2025
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	147	231	350	523	781	1165	1738	2592
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	12	18	27	39	57	84	124	182
.113	Enrichment Services	\$/SWU	238	350	514	755	1110	1631	2396	3521
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	919	1876	2757	4051	5952	8746	12851	18882
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Repository	\$/KgH	453	692	1412	2075	3049	4481	6583	9673
.60	Disposal of Spent Fuel	\$/KgH	932	1423	2090	3072	4513	6631	9743	14316

TABLE E4-3b
 ENERGY ECONOMIC DATA BASE
 OUTPUT NUCLEAR FUEL COST COMPONENTS
 Escalation at 8%/year
 Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
 System : HTGR-U5/U/Th-20%-T
 Start Up : January 1, 1995
 Bred Fuel Scenario: N/A

		OUTPUT QUANTITIES, \$/MBtu							30-YEAR
		ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							LEVELIZED
<u>Account No.</u>	<u>Account Description</u>	<u>1</u>	<u>5</u>	<u>10</u>	<u>15</u>	<u>20</u>	<u>25</u>	<u>30</u>	<u>TOTAL \$/MBtu</u>
.00	Total	3.58	3.01	4.47	6.56	9.83	14.42	21.24	6.55
.10	Initial Fuel Loaded								
.11	Uranium Supply	2.55	2.49	3.70	5.43	8.17	11.98	17.74	5.71
.111	U3O8 Supply								
.112	UF6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.38	0.20	0.31	0.44	0.64	0.98	1.41	0.50
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.22	0.14	0.20	0.30	0.45	0.64	0.92	0.14
.60	Disposal of Spent Fuel	0.43	0.18	0.26	0.39	0.57	0.82	1.17	0.20

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E4-4a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 8%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : HTGR-U5(DE)/U/Th-20%
Start Up : January 1, 1995
Bred Fuel Scenario: None

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1990	1995	2000	2005	2010	2015	2020	2025
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	147	231	350	523	781	1165	1738	2592
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	12	18	27	39	57	84	124	182
.113	Enrichment Services	\$/SWU	238	350	514	755	1110	1631	2396	3521
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value	0	0	0	0	0	0	0	0
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	919	1876	2757	4051	5952	8746	12851	18882
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	453	692	1412	2075	3049	4481	6583	9673
.60	Reprocessing	\$/KgH	1358	2769	4068	5977	8782	12904	18960	27859
.70	Disposal of Reprocessing Wastes	\$/KgH	306	450	661	971	1427	2097	3081	4527
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value	0	0	0	0	0	0	0	0
.90	Refabrication of Recovered Fuel	\$/KgH	3742	5432	7982	11727	17231	25319	37201	54661

TABLE E4-4b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 8%/year
Constant January 1, 1978 Dollars

Effective Date January 1, 1978
System HTGR-U5 (DE)/U/Th-20%
Start Up January 1, 1995
Bred Fuel Scenario None

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	3.84	2.82	4.43	6.42	9.66	13.95	35.83	6.17
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	2.55	2.00	3.21	4.67	7.07	10.03	26.17	4.97
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	0.34	0.18	0.25	0.37	0.55	0.83	2.19	0.61 ⁽⁴⁾
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.22	0.14	0.22	0.31	0.46	0.69	1.53	0.15
.60	Reprocessing								
.70	Disposal of Reprocessing Wastes }	0.73	0.41	0.62	0.89	1.31	1.99	4.85	0.44
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel	0.00	0.09	0.13	0.18	0.27	0.41	1.09	(4)

- (1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.
- (2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.
- (3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.
- (4) Levelized fabrication cost under account .20 includes refabrication cost of account .90.

Note The 30-Year Levelized Costs Include Indirect Costs

TABLE E4-5a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 8%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : CANDU-U5 (NAT)/U-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1990	1995	2000	2005	2010	2015	2020	2025
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	147	231	350	523	781	1165	1738	2592
.112	UF ₆ Conversion Services	\$/KgU as UF ₆								
.113	Enrichment Services	\$/SWU								
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	262	400	588	863	1269	1864	2739	4024
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Repository	\$/KgH	33	46	68	100	146	215	316	464
.60	Disposal of Spent Fuel	\$/KgH	209	319	469	689	1012	1488	2186	3211

TABLE E4-5b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 8%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : CANDU-U5(NAT)/U-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	3.86	3.84	5.82	8.49	12.21	18.44	26.50	6.68
.10	Initial Fuel Loaded								
.11	Uranium Supply	1.68	1.73	2.64	3.74	5.61	8.54	12.98	3.17
.111	U3O8 Supply								
.112	UF6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	1.10	1.05	1.58	2.36	3.28	4.92	7.37	1.91
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.14	0.13	0.20	0.30	0.42	0.63	0.78	0.20
.60	Disposal of Spent Fuel	0.94	0.93	1.40	2.09	2.90	4.35	5.37	1.40

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E4-6a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 8%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : CANDU-U5(SE)/U-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			1990	1995	2000	2005	2010	2015	2020	2025
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈	147	231	350	523	781	1165	1738	2592
.112	UF ₆ Conversion Services	\$/KgU as UF ₆	12	18	27	39	57	84	124	182
.113	Enrichment Services	\$/SWU	229	350	514	755	1110	1631	2396	3521
.114	Depleted U Supply	\$/KgU								
.12	Plutonium Supply	Parity value								
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH	262	400	588	863	1269	1864	2739	4024
.21	Core Fabrication	\$/KgH								
.22	Axial Blanket Fabrication	\$/KgH								
.23	Radial Blanket Fabrication	\$/KgH								
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Repository	\$/KgH	33	46	68	100	146	215	316	464
.60	Disposal of Spent Fuel	\$/KgH	209	319	469	689	1012	1488	2186	3211

TABLE E4-6b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 8%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : CANDU-U5(SE)/U-T
Start Up : January 1, 1995
Bred Fuel Scenario: N/A

		OUTPUT QUANTITIES, \$/MBtu							30-YEAR
		ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							LEVELIZED
<u>Account No.</u>	<u>Account Description</u>	<u>1</u>	<u>5</u>	<u>10</u>	<u>15</u>	<u>20</u>	<u>25</u>	<u>30</u>	<u>TOTAL \$/MBtu</u>
.00	Total	2.38	1.75	2.70	4.05	5.94	8.61	12.38	3.55
.10	Initial Fuel Loaded								
.11	Uranium Supply	1.11	1.11	1.72	2.58	3.90	5.56	8.40	2.44
.111	U3O8 Supply								
.112	UF6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply								
.13	U-233 Supply								
.14	Thorium Supply								
.20	Fabrication	0.63	0.30	0.45	0.68	0.94	1.41	2.11	0.67
.21	Core Fabrication								
.22	Axial Blanket Fabrication								
.23	Radial Blanket Fabrication								
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Repository	0.08	0.04	0.07	0.10	0.14	0.21	0.24	0.05
.60	Disposal of Spent Fuel	0.56	0.30	0.46	0.69	0.96	1.43	1.63	0.39

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E4-7a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 8%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : LMFBR-Pu/U/U/U-HT
Start Up : January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.112	UF ₆ Conversion Services	\$/KgU as UF ₆								
.113	Enrichment Services	\$/SWU								
.114	Depleted U Supply	\$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH								
.21	Core Fabrication	\$/KgH	4345	6384	9380	13782	20251	29755	43719	64238
.22	Axial Blanket Fabrication	\$/KgH	277	407	598	878	1290	1896	2786	4093
.23	Radial Blanket Fabrication	\$/KgH	1000	1469	2159	3172	4661	6849	10063	14786
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	531	780	1147	1685	2475	3637	5344	7852
.60	Reprocessing	\$/KgH	2090	2706	3306	4660	6847	10060	14782	21719
.70	Disposal of Reprocessing Wastes	\$/KgH	1096	1610	2366	3477	5109	7506	11029	16206
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value								
.90	Refabrication of Recovered Fuel	\$/KgH								

TABLE E4-7b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 8%/year
Constant January 1, 1978 Dollars

Effective Date January 1, 1978
System LMFBR-Pu/U/U/U-HT
Start Up January 1, 2001
Bred Fuel Scenario 1

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	4.46	3.29	4.57	6.86	9.96	14.66	21.72	5.00
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.111	U ₃ O ₈ Supply								
.112	UF ₆ Conversion Services	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾								
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	1.48	1.21	1.69	2.56	3.86	5.43	8.17	2.46 ⁽⁴⁾
.21	Core Fabrication	1.16	1.02	1.43	2.17	3.27	4.59	6.93	
.22	Axial Blanket Fabrication	0.05	0.06	0.07	0.11	0.17	0.24	0.36	
.23	Radial Blanket Fabrication	0.27	0.13	0.19	0.28	0.42	0.60	0.88	
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.46	0.35	0.52	0.78	1.11	1.68	2.47	0.44
.60	Reprocessing								
.70	Disposal of Reprocessing Wastes	2.52	1.73	2.36	3.52	4.99	7.55	11.08	2.10
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
.812	Equivalent UF ₆ Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel								

(1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.

(2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.

(3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.

(4) Includes fabrication of core, axial blanket and radial blanket (account .21, .22 and .23).

Note The 30-Year Levelized Costs Include Indirect Costs

TABLE E4-8a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 8%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : LMFBR-Pu/U/Th/Th-HT
Start Up : January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/1b U ₃ O ₈								
.112	UF ₆ Conversion Services	\$/KgU as UF ₆								
.113	Enrichment Services	\$/SWU								
.114	Depleted U Supply	\$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value	0	0	0	0	0	0	0	0
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH								
.21	Core Fabrication	\$/KgH	4345	6384	9380	13782	20251	29755	43719	64238
.22	Axial Blanket Fabrication	\$/KgH	446	656	964	1416	2080	3057	4491	6599
.23	Radial Blanket Fabrication	\$/KgH	1170	1718	2525	3710	5451	8009	11768	17292
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	531	780	1147	1685	2475	3637	5344	7852
.60	Reprocessing	\$/KgH	2090	2706	3306	4660	6847	10060	14782	21719
.70	Disposal of Reprocessing Wastes	\$/KgH	1096	1610	2366	3477	5109	7506	11029	16206
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/1b U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value	0	0	0	0	0	0	0	0
.90	Refabrication of Recovered Fuel	\$/KgH								

TABLE E4-8b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 8%/year
Constant January 1, 1978 Dollars

Effective Date January 1, 1978
System LMFBR-Pu/U/Th/Th-HT
Start Up January 1, 2001
Bred Fuel Scenario 1

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	5.74	4.03	5.71	8.39	12.32	18.11	27.07	6 26
0	Initial Fuel Loaded								
1	Uranium Supply ⁽¹⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0 00
1	U ₃ O ₈ Supply								
12	UF ₆ Conversion Services								
113	Enrichment Services								
114	Depleted U Supply								
2	Plutonium Supply ⁽²⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0 00
3	U-233 Supply ⁽³⁾								
14	Thorium Supply								
20	Fabrication	2.06	1.52	2.25	3.31	4.86	7.14	10.59	3.18 ⁽⁴⁾
21	Core Fabrication	1.61	1.27	1.88	2.77	4.07	5.98	8 78	
22	Axial Blanket Fabrication	0 12	0.09	0.14	0 19	0.28	0 41	0.62	
23	Radial Blanket Fabrication	0.33	0.16	0.23	0.35	0 51	0 75	1 19	
.30	Shipping to Temporary Storage								
40	Temporary Storage								
50	Shipping to Reprocessor	0 55	0 41	0.61	0.89	1.31	1 93	2.90	0 52
.60	Reprocessing								
70	Disposal of Reprocessing Wastes }	3.13	2 10	2.85	4.19	6.15	9 04	13 58	2.56
80	Final Fuel Recovered (Credits)								
81	Uranium ⁽¹⁾								
.811	Equivalent U ₃ O ₈ Supply								
812	Equivalent UF ₆ Conversion Services								
813	Equivalent Enrichment Services								
82	Fissile Plutonium ⁽²⁾								
83	Bred U-233 ⁽³⁾								
90	Refabrication of Recovered Fuel								

- (1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account 11 represents the net uranium consumed.
- (2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account 12) such that the value entered under account .12 represents the net fissile plutonium consumed.
- (3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.
- (4) Includes fabrication of core, axial blanket and radial blanket (account .21, 22 and .23)

Note The 30-Year Levelized Costs Include Indirect Costs

TABLE E4-9a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 8% year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : GCFR-Pu/U/U/U
Start Up : January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.112	UF ₆ Conversion Services	\$/KgU as UF ₆								
.113	Enrichment Services	\$/SWU								
.114	Depleted U Supply	\$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value								
.14	Thorium Supply	\$/KgH								
.20	Fabrication	\$/KgH								
.21	Core Fabrication	\$/KgH	4757	6990	10270	15090	22173	32579	47870	70336
.22	Axial Blanket Fabrication	\$/KgH	277	407	598	878	1290	1896	2786	4093
.23	Radial Blanket Fabrication	\$/KgH	1000	1469	2159	3172	4661	6849	10063	14786
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	531	780	1147	1685	2475	3637	5344	7852
.60	Reprocessing	\$/KgH	2090	2706	3306	4660	6847	10060	14782	21719
.70	Disposal of Reprocessing Wastes	\$/KgH	1096	1610	2366	3477	5109	7506	11029	16206
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value								
.90	Refabrication of Recovered Fuel	\$/KgH								

TABLE E4-9b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 8%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System: GCFR-Pu/U/U/U
Start Up: January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							30-YEAR LEVELIZED TOTAL \$/MBtu
		1	5	10	15	20	25	30	
.00	Total	6.25	3.94	5.52	7.91	11.92	17.45	25.66	5.54
.10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.111	U3O8 Supply								
.112	UF6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
.20	Fabrication	1.78	1.13	1.64	2.31	3.55	5.21	7.65	2.64 ⁽⁴⁾
.21	Core Fabrication	1.17	0.81	1.19	1.75	2.57	3.77	5.54	
.22	Axial Blanket Fabrication	0.08	0.06	0.07	0.10	0.17	0.25	0.36	
.23	Radial Blanket Fabrication	0.53	0.26	0.38	0.46	0.81	1.19	1.75	
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.67	0.46	0.68	0.98	1.47	2.14	3.15	0.49
.60	Reprocessing								
.70	Disposal of Reprocessing Wastes	3.80	2.35	3.20	4.62	6.90	10.10	14.86	2.41
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U3O8 Supply								
.812	Equivalent UF6 Conversion Services								
.813	Equivalent Enrichment Services								
.82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel								

(1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.

(2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.

(3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.

(4) Includes fabrication of core, axial blanket and radial blanket (account .21, .22 and .23).

Note: The 30-Year Levelized Costs Include Indirect Costs

TABLE E4-10a
ENERGY ECONOMIC DATA BASE
INPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 8%/year
Constant January 1, 1978 Dollars

Effective Date: January 1, 1978
System : GCFR-Pu/U/Th/Th
Start Up : January 1, 2001
Bred Fuel Scenario: 1

Account No.	Account Description	Units	INPUT QUANTITIES BY CALENDAR YEAR							
			2000	2005	2010	2015	2020	2025	2030	2035
.10	Initial Fuel Loaded	\$/KgH								
.11	Uranium Supply	\$/KgU								
.111	U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.112	UF ₆ Conversion Services	\$/KgU as UF ₆								
.113	Enrichment Services	\$/SWU								
.114	Depleted U Supply	\$/KgU	0	0	0	0	0	0	0	0
.12	Plutonium Supply	Parity value	0	0	0	0	0	0	0	0
.13	U-233 Supply	Parity value	0	0	0	0	0	0	0	0
.14	Thorium Supply	\$/KgH			-					
.20	Fabrication	\$/KgH								
.21	Core Fabrication	\$/KgH	4757	6990	10270	15090	22173	32579	47870	70336
.22	Axial Blanket Fabrication	\$/KgH	446	656	964	1416	2080	3057	4491	6599
.23	Radial Blanket Fabrication	\$/KgH	1170	1718	2525	3710	5451	8009	11768	17292
.30	Shipping to Temporary Storage	\$/KgH								
.40	Temporary Storage	\$/KgH								
.50	Shipping to Reprocessor	\$/KgH	531	780	1147	1685	2475	3637	5344	7852
.60	Reprocessing	\$/KgH	2090	2706	3306	4660	6847	10060	14782	21719
.70	Disposal of Reprocessing Wastes	\$/KgH	1096	1610	2366	3477	5109	7506	11029	16206
.80	Final Fuel Recovered (Credits)	\$/KgH								
.81	Uranium	\$/KgH	0	0	0	0	0	0	0	0
.811	Equivalent U ₃ O ₈ Supply	\$/lb U ₃ O ₈								
.812	Equivalent UF ₆ Conversion Services	\$/KgU								
.813	Equivalent Enrichment Services	\$/SWU								
.82	Fissile Plutonium	Parity value	0	0	0	0	0	0	0	0
.83	Bred U-233	Parity value	0	0	0	0	0	0	0	0
.90	Refabrication of Recovered Fuel	\$/KgH								

TABLE E4-10b
ENERGY ECONOMIC DATA BASE
OUTPUT NUCLEAR FUEL COST COMPONENTS
Escalation at 8%/year
Constant January 1, 1978 Dollars

Effective Date January 1, 1978
System GCFR-Pu/U/Th/Th
Start Up January 1, 2001
Bred Fuel Scenario 1

Account No.	Account Description	OUTPUT QUANTITIES, \$/MBtu							30-YEAR LEVELIZED TOTAL \$/MBtu
		ANNUAL DIRECT FUEL EXPENSE BY REACTOR OPERATING YEAR							
		1	5	10	15	20	25	30	
.00	Total	5.79	3.68	5.14	7.46	11.10	16.26	23.91	5.32
10	Initial Fuel Loaded								
.11	Uranium Supply ⁽¹⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.111	U3O8 Supply								
.112	UF6 Conversion Services								
.113	Enrichment Services								
.114	Depleted U Supply								
.12	Plutonium Supply ⁽²⁾	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.13	U-233 Supply ⁽³⁾								
.14	Thorium Supply								
20	Fabrication	1.82	1.15	1.67	2.45	3.62	5.31	7.80	2.72 ⁽⁴⁾
.21	Core Fabrication	1.18	0.81	1.18	1.74	2.56	3.76	5.53	
22	Axial Blanket Fabrication	0.11	0.07	0.11	0.16	0.24	0.35	0.51	
.23	Radial Blanket Fabrication	0.53	0.27	0.38	0.55	0.82	1.20	1.76	
.30	Shipping to Temporary Storage								
.40	Temporary Storage								
.50	Shipping to Reprocessor	0.60	0.42	0.61	0.88	1.31	1.92	2.83	0.44
.60	Reprocessing								
.70	Disposal of Reprocessing Wastes }	3.37	2.11	2.86	4.13	6.17	9.03	13.28	2.16
.80	Final Fuel Recovered (Credits)								
.81	Uranium ⁽¹⁾								
.811	Equivalent U3O8 Supply								
.812	Equivalent UF6 Conversion Services								
.813	Equivalent Enrichment Services								
82	Fissile Plutonium ⁽²⁾								
.83	Bred U-233 ⁽³⁾								
.90	Refabrication of Recovered Fuel								

(1) Final uranium value (account .81) is included in Uranium Supply (account .11) such that the value entered under account .11 represents the net uranium consumed.

(2) Final value of fissile plutonium (account .82) is included in Plutonium Supply (account .12) such that the value entered under account .12 represents the net fissile plutonium consumed.

(3) Where bred U-233 is involved (HTGR, thorium blankets in FBR), the net value of U-233 (account .13 less account .83) is included in account .11, Uranium Supply.

(4) Includes fabrication of core, axial blanket and radial blanket (account .21, .22 and .23)

Note The 30-Year Levelized Costs Include Indirect Costs

APPENDIX F

APPENDIX F

FUEL COSTING METHODOLOGY

The material contained in this Appendix describes the fuel costing methodology used by NUS Corporation for EEDB. It consists of the following sections, extracted from three of the final series* of NUS Corporation EEDB Fuel Cycle reports:

- a. NUS-3190, "Fuel Cycle Cost Estimates for LWR, HTGR, CANDU - Type HWR, LMFBR and GCFR"; Section 3.0, "Fuel Costing Methodology."
- b. NUS-3190, "Fuel Cycle Cost Estimates for LWR, HTGR, CANDU - Type HWR, LMFBR and GCFR"; Section 6.5, "Discount and Interest Rates."
- c. NUS-3244, "Additional Fuel Cost Studies - Escalation, 2001 Startup and CANDU Thorium System"; Section 3.0, "Effects of Escalation."

*Refer also to Appendix "B".

NUS-3190

"Fuel Cycle Cost Estimates for LWR, HTGR, CANDU -
Type HWR, LMFBR and GCFR"; Section 3.0, "Fuel Costing Methodology"

Fuel cycle costs presented in this report are based on the theory described in Appendix E to NUS-531, Guide for Economic Evaluation of Nuclear Plant Designs.⁽¹⁾ Calculations have been performed using FUELCOST-V,⁽²⁾ a proprietary computer program developed by NUS. The discussion in the remainder of this section is presented according to the following sequence:

- Description of the costing methodology currently used by FUELCOST-V is outlined. This description is primarily intended to provide the basis for comparison with the methods of NUS-531.
- The discount cash flow technique developed in NUS-531, Guide for Economic Evaluation of Nuclear Reactor Plant Designs is discussed next. Complex discount equations are simplified by making certain assumptions and made applicable specifically to calculation of nuclear fuel cycle costs.

3.1

FUELCOST-V Theory

In FUELCOST-V, the utility economics of using nuclear fuel for the purpose of generating electricity is simulated (i) by providing "direct costs" for materials, processes and services as input by the user, and (ii) by estimating indirect costs by an "interest rate" approach. As will be shown later, the "interest rate" approach is derivable from a discount cash flow approach. First certain terms are defined below.

- The quantity of fuel, which maintains its identity throughout the computation is called a batch. Batches have a predetermined sequencing of insertion into and discharge from the reactor, produce energy at a predetermined rate and have their own unique economic history.

- The term "direct cost" refers to expenses paid for materials, processes and services less credits received for materials sold or realized. Some of these items occur prior to insertion of nuclear fuel in the reactor, and the remaining items occur after nuclear fuel is discharged from the reactor.
- The term "indirect cost" usually includes (i) interest on borrowed money, (ii) return on equity, (iii) federal and state income taxes, (iv) other taxes, and (v) other costs associated with the time value of money.
- The term "unit cost" means cost per unit of energy, such as \$/MBTU or mills/kwhe.

FUELCOST-V performs a cost accounting of each batch of fuel, a batch defined by the user. The theory of the code is based on the premise that the revenue required during the in-core irradiation phase must exactly equal the sum of all costs; direct and indirect. This total revenue requirement, when divided by the energy generated by the batch yields a batch unit cost. Total core revenue requirements and unit costs are then derived from the batch revenue requirements and unit costs, respectively. The revenue requirements are assumed to equal the amount of amortization cost over any time period.

3.1.1 Calculation of Direct Cost

Although direct costs are provided by the user as input, FUELCOST-V takes these input values, makes adjustments to them to reflect the time value of money spent both before and after irradiation of nuclear fuel, and amortizes the net direct costs in proportion to the amount of energy generated over a

fixed calendar time called an accounting interval (month, quarter year, half year, or year), generally in accordance with the following methods:

Direct costs incurred prior to insertion of nuclear fuel into a reactor are future-worthed in order to move them from the time they occur to the insertion date (often called "pre-reactor accruals"). Direct costs incurred (or realized as the credit) after the fuel is discharged from the reactor are present-worthed to move them from the time they occur to the discharge date (often called "post-reactor discounts"). In order to accommodate these adjustments in direct costs, FUELCOST-V has input entries for interest rates applicable to both pre-reactor period and post-reactor period.

Once the initial value of nuclear fuel (including pre-reactor accruals) and the final value of nuclear fuel (including post-reactor discounts)* are established, the difference between the two, i.e., net direct costs, is amortized in accordance with the amount of energy generated (e.g., MWD/MTHM per cycle). This completes the calculation of direct costs for a given batch. What FUELCOST-V does with these direct costs will be described following discussions on indirect costs.

3.1.2 Calculation of Indirect Costs

The proper calculation of indirect costs requires that all the factors affecting them must be specified over the time period for which fuel cost is being calculated. Even with this information, it is not generally possible to derive a

* Final value of nuclear fuel represents the net salvage value of nuclear fuel, i.e., the value of unburned fissile material remaining in the discharged fuel less the cost of recovery. The net salvage value of nuclear fuel may be positive, zero, or negative, depending upon assumptions made in fuel cycle prices for each step of the fuel cycle.

linear relationship between direct and indirect costs. In the general case, indirect costs can be determined only through a detailed cash flow analysis. This subject is covered in more detail in NUS-531, Guide for Economic Evaluation of Nuclear Reactor Plant Designs.

FUELCOST-V treats indirect costs like an interest cost on borrowed money, using annual rates specified by the user. Such an interest rate may be thought of as the composite cost of money, including borrowing costs, rate of return on equity, and taxes. When this rate is applied to the unrecovered expense, the result yields the indirect cost.

This method of computing indirect costs is derivable from a discounted cash flow formulation as shown by the following example:

A batch of fuel, inserted into a reactor at time, t_1 , has an initial cost at t_1 of D_1 . At t_3 this batch is discharged with an immediate income credited to the batch of D_2 (a negative cost). All energy, Q , is produced instantaneously at t_2 , the center of the interval (or, alternatively, uniformly over the interval), which generates revenues at a rate, P (to be determined) which pays for expenditure D_1 , less the credit D_2 . The computational method applied to evaluation of P allows for the time difference between when D_1 and D_2 occurs and when revenues are received. (Note: total revenues equal P times Q).

In FUELCOST-V the further assumption is made that the present value of all revenues are equal to the present value of all expenses. Putting this into mathematical terms, we have:

$$P \left(\frac{Q}{(1+x)^{t_3}} \right) = \frac{D_1}{(1+x)^{t_1}} + \frac{(-D_2)}{(1+x)^{t_3}}$$

Where x = discount rate

Then,

$$P = \frac{D_1}{Q} \left[(1+x)^{t_2-t_1} \right] - \frac{D_2}{Q} \left[(1+x)^{t_2-t_3} \right]$$

If x is small, the following approximation can be made:

$$(1+x)^{\Delta t} = 1 + (\Delta t)x$$

or,

$$P = \frac{D_1}{Q} \left[1 + (t_2 - t_1)x \right] - \frac{D_2}{Q} \left[1 + (t_2 - t_3)x \right]$$

Since t_3 is always greater than t_2 , this equation can be rewritten as follows:

$$P = \frac{D_1}{Q} - \frac{D_2}{Q} + \left[\frac{D_1(t_2 - t_1)x + D_2(t_3 - t_2)x}{Q} \right]$$

But since t_2 is mid-way between t_1 and t_3

$$\begin{aligned} P &= \frac{D_1 - D_2}{Q} + \frac{x(t_3 - t_1)}{Q} \frac{D_1 + D_2}{2} \\ &= \text{direct cost} + \text{indirect cost} \end{aligned}$$

Thus, FUELCOST-V calculates the indirect cost as equal to simple interest on the average balance over the period of energy production at an interest rate, x , equal to the discount rate, which is approximately equivalent to a discounted cash flow approach:

Figure 3-1 illustrates, in simplified form, the time behavior of unrecovered expense for a batch of fuel. The sloping line from T_a to T_b approximates progress payments made prior to the use of the fuel in the reactor. The capital is then idle from T_b to T_c . The time interval from T_a through T_c is the pre-reactor time. Beginning at time T_c , revenues are assumed to be continuously received as the fuel produces salable energy, and these revenues reduce the outstanding debt to Y_d at time T_d . The remaining debt, Y_d , is finally reduced to zero at time T_p when, for example, the credit for recovered fuel is realized. Thus, for this batch of fuel, it started with zero outstanding debt at T_a , and it ended with zero outstanding balance at T_p . The time interval from T_c to T_d is the in-core time. The time interval from T_d to T_p represents the post-reactor time.

The interest-rate approach uses the formula for calculating interest which relates interest cost to 1) the interest rate, 2) the time-averaged unrecovered expense, and 3) the duration of time that the debt exists. That is,

$$J = \bar{Y} i t$$

where

J = interest cost, dollars

$\bar{Y}$ = unrecovered expense averaged over the time, t , dollars

i = interest rate, fraction per annum

t = time duration, years

When the interest rate varies with time, the equation becomes

$$J = \sum_{n=1}^N \bar{Y}_n i_n t_n$$

In which $\bar{Y}_n$, i_n , and t_n represent values of $\bar{Y}$, i , and t in the n^{th} time period, and N is the total number of discrete time periods considered in the analysis. For a given batch of fuel, the unrecovered expense at any time may be

Figure 3-1

Time History of Unrecovered Expense
for a Batch of Fuel

thought of as the net expenditures up to that time less net revenues. Obviously, this number will vary with time as the fuel is depleted and revenues are received from the sale of energy.

For example, consider the in-core time and in-core indirect costs. For any discrete time period of between T_c and T_d , FUELCOST-V calculates the indirect cost, J , based on the following expression:

$$J = \frac{Y_i + Y_f}{2} \cdot i \cdot t$$

where

Y_i	=	Initial value of outstanding debt
Y_f	=	Final value of outstanding debt
i	=	Total cost of money
t	=	Time period

Thus, the user must specify the total cost of money, i , which when multiplied by the average unexpensed amount, $(Y_i + Y_f)/2$, over a given time period, t , yields an estimate of the indirect costs.

Note that, if the total cost of money, i , is set equal to zero, the indirect cost becomes zero, and fuel cost result calculated by FUELCOST-V will represent the direct cost only.

The flow of money illustrated in Figure 3-1 is idealized in that progress payments cannot usually be represented by a straight line, and revenues from the sale of energy are received at various times and are generally not uniform in magnitude since they are a function of the rate at which energy is produced. But even if the shape of the curve of unrecovered expense versus time becomes more complicated than that shown in the figure, the general approach is unchanged.

3.1.3 Levelized Fuel Cycle Cost

In FUELCOST-V, "all expenses" are calculated for each batch in terms of direct and indirect costs based on methodologies described above for each. For a multi-batch problem, individual batch results are superimposed, and the levelized unit fuel cycle cost, P , in either mills/kwhe or \$/MBTU, is calculated based on the following equation:

$$P = \frac{\sum_{n=1}^N \frac{a(n)}{(1+x)^n}}{\sum_{n=1}^N \frac{Q(n)}{(1+x)^n}}$$

where

P = Levelized fuel cycle cost over a time period of N years

$a(n)$ = Direct plus indirect costs for a time period of n

$Q(n)$ = Energy generated (either kwhe or MBTU) over a time period of n

x = Discount rate in fraction

N = Total number of years

Notice that $a(n)$ shown in the above equation consists of direct and indirect costs discussed in Section 3.1.1 and 3.1.2, respectively. In other words, the numerator of the equation P represents the present value of direct cost plus the present value of indirect cost.

3.2 Discount Cash Flow Theory

In any economic analysis, the cash flow technique is considered to be basic; any simplified method of analysis, such as that described in Section 3.1 for FUELCOST-V, must be referred back to it to identify derived quantities. In a cash flow formulation, certain assumptions made to simplify it (to reduce the complex equations to more manageable forms), and specific application of the cash flow technique to fuel cost analysis are all described in detail in NUS-531. A detailed treatment is presented in Appendix E to NUS-531, and the derivation will not be repeated in this report. Instead the final equation which has a direct bearing on calculating nuclear fuel cycle costs in this study will be discussed for the purpose of how FUELCOST-V can be used to replicate the discount cash flow theory.

From the discount cash flow theory, it can be shown that the unit fuel cost, P (mills/kwhe or \$/MBTU), can be calculated by the following equation:

$$P = \frac{\sum_{n=0}^N \frac{Z(n) - V(n) + [O(n) - W(n)] (1-r)}{(1+x)^n} - r \sum_{n=1}^N \frac{d(n) Q(n)}{(1+x)^n}}{(1-r) \sum_{n=1}^N \frac{Q(n)}{(1+x)^n}}$$

where

- n = an accounting period
- N = duration of the history in accounting periods
- x = $(1-r)(b_j + h) + (1-b)i$, an effective discount rate in fraction per accounting period
- Z(n) = investment during period, n
- V(n) = income from other than energy sale, non profitable (and, therefore, non-taxable income)

- $O(n)$ = deductible operating costs
 $W(n)$ = taxable income from sources other than the sale of energy
 $d(n)$ = unit direct cost (mills/kwhe or \$/MBTU)
 $Q(n)$ = amount of energy sold which is assumed to produce revenue at the end of accounting period, n
 r = tax rate on taxable income in fraction
 b = fractional indebtedness in bonds
 j = required return on bonds
 h = insurance and local taxes on fuel
 i = effective return on $(1 - b)$ fraction of total indebtedness (equity)

Before each of the terms contained in the above equation is discussed, let us assume for simplicity that $O(n)$ and h are equal to zero. This assumption does not disturb the generality of this equation. The above equation can then be separated into three terms as shown below:

$$P = \frac{\sum_{n=0}^N \frac{Z(n) - V(n)}{(1+x)^n}}{(1-r) \sum_{n=1}^N \frac{Q(n)}{(1+x)^n}} - \frac{\sum_{n=0}^N \frac{W(n)}{(1+x)^n}}{\sum_{n=1}^N \frac{Q(n)}{(1+x)^n}} - \frac{r}{1-r} \frac{\sum_{n=1}^N \frac{d(n) Q(n)}{(1+x)^n}}{\sum_{n=1}^N \frac{Q(n)}{(1+x)^n}}$$

or,

$$P = \frac{1}{1-r} [A] - [C] - \frac{r}{1-r} [B]$$

And, the discount rate, X , is now defined by the following equation:

$$x = (1-r) b j + (1-b) i$$

To apply this discount cash flow equation to circumstances corresponding to nuclear fuel cycle costs, each of the terms, A, B and C, will now be related to more specific fuel cost components;

- A = present value of investments made in fuel cycle materials, processes, and services less spent fuel credits divided by the present value of energy.
- B = present value of direct (amortization) costs divided by the present value of energy.
- C = present value of profitable sales, if any, divided by the present value of energy.

Each of the terms, A, B and C will now be discussed in more detail.

3.2.1 Deductible Direct Costs

Referring to the theoretical development in NUS-531, Appendix E, a careful definition is required of the tax deductible "depreciation" term, $D(n)$.

NUS-531 defines a unit direct fuel cost, $d(n)$, as

$$d(n) Q(n) = D(n)$$

In other words, a unit direct cost times an amount of energy yields a dollar amount to be deducted from income before calculating income taxes. NUS-531 also states that the unit direct costs must satisfy the relationship,

$$\sum_{n=1}^N d(n) Q(n) = \sum_{n=0}^N (Z(n) - V(n))$$

That is, over the time period under study, the sum of all investments $Z(n)$, less any non-profitable income, $V(n)$, must equal the total dollars deducted from income for purposes of computing income taxes. This treats unit direct fuel cost like a deductible operating cost, or very much like a "depreciation" cost.

Referring to the general principles of FERC accounting,⁽³⁾ the "depreciation" of nuclear fuel is "amortization," but for tax purposes is deductible just like depreciation. "Amortization," however, is only deductible as the fuel is burned; "depreciation" on the other hand, implies a continuing decline in value with time even if the equipment is not in use. Amortization is the proper terminology to use for nuclear fuel.

The dollar expense which is amortized is usually given by the "original cost" minus any "net salvage value." "Original cost" is analogous to the total utility investment for a batch at the front end of the fuel cycle (e.g., U_3O_8 , SWU, etc.) In NUS-531, these investments are labelled $Z(n)$. The "net salvage value" is the residual fuel value minus the cost of processing after discharge, i.e., the back end credits less costs. The "net salvage value" can be positive, zero, or negative, since the back end costs may be less than, equal to, or greater than the assumed credits for residual fissile values in the fuel, respectively. In the terminology of NUS-531, $V(n)$ is equal to the assumed credits for sale of residual fuel values. The back end costs are part of $Z(n)$. However, the resulting value for levelized cost, P , will be unchanged if one defines $V(n)$ as the net difference between the costs and credits.

3.2.2 Profitable Sales Other Than Energy

In NUS-531 provision is made for profitable sales, $W(n)$. Profitable sales occur if an item is sold for more than it is valued. For instance, if a utility has specified a net salvage value for fuel and recovers exactly this value in dollars, then there is no actual difference between what electricity rates were based upon and what the utility actually experienced. If a utility realizes more or less than the net salvage value, the difference has tax implications at the time it is realized. For example, if the net salvage value was estimated at \$M and when the fuel was finally reprocessed the income from sale of spent fuel products resulted in an excess over \$M, the excess is taxable (labelled $W(n)$ in NUS-531).

For fuel cost evaluations in this study, it appears as if the $W(n)$ term will always equal zero. It could be non-zero if one wanted to look at off-target planning of net salvage values, but this is considered to be beyond the scope of this study. Therefore, it appears as if we can ignore "profitable sales" in the fuel cost analyses for this study.

3.2.3 Simplified Discount Cash Flow Equation

On the basis of discussions presented in Section 3.2.1 and 3.2.2, the unit fuel cost, P , can now be expressed by the following equation:

$$P = \frac{1}{1-r} [A] - \frac{r}{1-r} [B]$$

The term C is set equal to zero on the premise that there will be no taxable income received from sources other than the sale of energy. The term B represents the direct (amortization) cost while $(P - B)$ represents the indirect cost.

It is noted that, by setting h equal to zero earlier in this section, the simplified discount cash flow equation, shown above, implicitly assumes that the insurance on fuel and local taxes on fuel are zero. Furthermore, if the statutory federal income tax rate, r , is assumed to be zero, the total costs are simply the term, A .

3.3 Use of FUELCOST-V

The terms A and B were calculated by FUELCOST-V, and they were adjusted by $1/(1 - r)$ and $r/(1 - r)$, respectively to derive the unit levelized fuel cost, P .

In appendix B in which detailed fuel cost results are presented, the annual direct fuel expense given by reactor operating year represents the term, B , and the 30-year levelized total \$/MBTU represents, P .

NUS-3190

"Fuel Cycle Cost Estimates for LWR, HTGR, CANDU -
Type HWR, LMFBR and GCFR"; Section 6.5, "Discount and Interest Rates"

6.5 Discount and Interest Rates

A discount rate of 4.45%/year was consistently used throughout this report. The basis for it is described in this section. FUELCOST-V calculates the indirect cost as equal to simple interest on the average balance over the period of energy production at an interest rate equal to the discount rate, which is approximately equivalent to a discount cash flow approach (see Section 3.1.2). Thus, an interest rate of 4.45%/year was also used for calculating (i) pre-reactor accruals, (ii) post-reactor discounts, and (iii) indirect costs.

The following equation for an effective discount rate⁽¹⁾ will be used as a starting point.

$$x = (1 - r)(bj + h) + (1 - b) i$$

where

x	=	effective discount rate
r	=	FIT rate on taxable income (0.48)
b	=	fraction of debt capital
j	=	debt interest rate
h	=	insurance and local taxes, etc.
(1 - b)	=	fraction of equity capital
i	=	equity interest rate

For the purpose of this study, it will be assumed that "h" is equal to zero. It will be further assumed that "j" and "i" in this equation represent debt and equity interest rates inclusive of the effect of inflation. Then, the equation for x becomes,

$$x = (1 - r) bj + (1 - b) i$$

When dealing with constant dollars, which is the case in this study, the long-term real money cost should exclude the effect of inflation. Since the equation for x is assumed to be the discount rate inclusive of the effect of inflation, the inflation-free effective discount rate, x_1 , can be expressed by the following equation:

$$x_1 = (1 - r) \cdot b(j - d) + (1 - b) (i - d)$$

where "d" is a deflator, which is used to exclude the effect of inflation from x .

Note that $(j - d)$ and $(i - d)$ represent debt and equity interest rates without the effect of inflation.

Several economic indicators are used to measure the past inflation effects. The following three (3) indicators are known to be frequently used for this purpose:

1. Consumer Price Index (CPI)
2. GNP Deflator (GNP)
3. Wholesale Price Index for Industrial Commodities (WPI)

The following data on the above economic indicators were obtained:

<u>Year</u>	<u>CPI</u> ⁽¹⁵⁾	<u>GNP</u> ⁽¹⁶⁾	<u>WPI</u> ⁽¹⁷⁾
1913	29.7	19.5	37.2
.	.	.	.
.	.	.	.
.	.	.	.
1977	181.5	141.29	195.2

These data can be used in the following manner:

$$I_1 (1 + d)^{1977-1913} = I_2$$

where

$$I_1 = \text{index for the year 1913}$$

$$I_2 = \text{index for the year 1977}$$

Then,

$$(1 + d)^{64} = \frac{I_2}{I_1}$$

or

$$\ln (1 + d) = \frac{\ln (I_2 / I_1)}{64}$$

$$\text{Let } a = \frac{\ln (I_2 / I_1)}{64}, \text{ then}$$

$$d = e^a - 1$$

The deflator, d, calculated by the above equation using various indicators shown above is summarized below:

	<u>d(%/yr)</u>
CPI	2.87
GNP	3.14
WPI	2.62

Based on this analysis, an average deflator of 3% per year was used in this study for both debt and equity interest rates to determine the inflation-free effective discount rate for constant-dollar cases.

The Federal Energy Regulatory Commission (formerly Federal Power Commission) publishes each year comprehensive financial and operating information on all the large electric utility companies operating in the United States. In that publication, the FERC includes average financial data in terms of the parameters of "b", "1 - b", "j" and "i" for both privately and publicly owned electric utility companies. Since the majority of large electric utility companies engaged in nuclear business are privately owned, the average financial data corresponding to privately owned electric utility companies was used for this study.

The latest version of this document was published for the year of 1976.⁽¹⁸⁾

In that document, the average financial data were provided as follows:

Percent Debt	51.4
Percent Equity	48.6
Debt Interest Rate	6.93
Equity Interest Rate	10.0 (inferred)

Using these data and the equation for x_1 , the effective discount rate for constant dollar cases can be calculated.

$$\begin{aligned}
 x_1 &= (1 - r) \cdot b (j - d) + (1 - b)(i - d) \\
 &= (1 - 0.48)(0.514)(0.0693 - 0.03) + (1 - 0.514)(0.10 - 0.03) \\
 &= 0.0105 + 0.0340 \\
 &= 0.445, (4.45\%/year)^*
 \end{aligned}$$

As a result, 4.45% per year discount rate was used in this study.

* It is noted that figures used for "b", "j" and "i" in the above calculation reflect the past trend through the year 1976. No adjustments were made to include two years of inflation effects between 1976 and 1978.

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"Additional Fuel Cost Studies - Escalation,
2001 Startup and CANDU Thorium System";
Section 3.0, "Effects of Escalation"

3.0 EFFECTS OF ESCALATION

The effects of future escalation upon 30-year levelized fuel cycle costs were evaluated for the ten (10) base reactor/fuel cycle systems (i) using escalation rates of 6%, 7%, and 8% per year, compounded annually, and (ii) maintaining the same commercial operation dates assumed in the previous report.⁽¹⁾ Under these circumstances, the impact of escalation on fuel cycle costs is much greater for systems starting operation in later years (e.g., FBRs in 2001) than those for systems starting operation in early years (e.g., HTGRs in 1995). This is expected simply because of added escalation (from January 1978) for systems starting operation in later years.

Therefore, it is noted that escalated fuel cycle costs presented in this report should not be used for the purpose of making comparative fuel cost analysis of alternate systems. Instead, they should be used to determine the fuel cost impacts of escalation for a given base reactor/fuel cycle system.

Fuel cycle cost results with escalation are summarized in Table 3-1 in comparison with those without escalation. Further breakdown of these fuel cycle costs is provided in Appendix A to this report in accordance with the fuel cost accounting format developed by NUS under a separate NUS Task 4, Definition of Fuel Cost Components.

Escalated fuel cycle costs shown in Table 3-1 are based on fuel cycle unit prices and discount rates discussed in the following sections.

3.1 Fuel Cycle Unit Prices

Fuel cycle unit prices projected in terms of January 1978 dollars⁽¹⁾ were escalated by ESC, a code to provide escalated cost data sets for the FUELCOST-V code.⁽²⁾ Escalation rates of 6%, 7%, and 8% per year were

TABLE 3-1

SUMMARY OF BASELINE FUEL CYCLE COSTS

Reactor/Fuel Cycle Designation	Assumed Reactor Commercial Operation Date	30-Year Levelized \$/MBTU			
		No Escalation	6%/yr Esc.	7%/yr Esc.	8%/yr Esc.
PWR-U5 (LE)/U-T	1987	0.72	2.35	2.82	3.36
PWR-U5 (LE)+Pu (RE)/U	1991	0.66	2.68	3.32	4.11
HTGR-U5/U/Th-20%-T	1995	0.75	3.93	5.08	6.55
HTGR-U5 (DE)/U/Th-20%	1995	0.72	3.72	4.80	6.17
CANDU-U5 (NAT)/U-T	1995	0.72	3.93	5.13	6.68
CANDU-U5 (SE)/U-T	1995	0.40	2.11	2.74	3.55
LMFBR-Pu/U/U/U-HT	2001	0.39	2.73	3.70	5.00
LMFBR-Pu/U/Th/Th-HT	2001	0.48	3.40	4.63	6.26
GCFR-Pu/U/U/U	2001	0.45	3.07	4.15	5.54
GCFR-Pu/U/Th/Th	2001	0.43	2.93	3.96	5.32

applied to all fuel cycle unit prices, some of which results are tabulated in Table 3-2 in comparison with non-escalated fuel cycle unit prices, i.e., January 1978 dollars.

3.2 Discount Rates

The discount rate of 4.45%/year used in the previous report⁽¹⁾ was the inflation-free discount rate calculated by the following equation:

$$x_1 = (1 - r) \cdot b (j - d) + (1 - b)(i - d)$$

where

x_1	=	discount rate exclusive of past inflation
r	=	FIT rate on taxable income (0.48)
b	=	fraction of debt capital
d	=	deflator
j	=	debt interest rate
$(1 - b)$	=	fraction of equity capital
i	=	equity interest rate

This inflation-free discount rate was used for constant-dollar cases (January 1978 dollars) assumed in the previous report based on the premise that the long-term real money cost should exclude the effect of past inflation.

When dealing with current-year-dollars, which is the case for escalated fuel cycle costs, the above equation should be modified as follows in order to properly reflect the effect of future inflation:

$$x_2 = (1 - r) \cdot b \{ (j - d) + f \} + (1 - b) \{ (i - d) + f \}$$

where

x_2	=	discount rate inclusive of future inflation
f	=	assumed escalation rate.

TABLE 3-2

SUMMARY OF FUEL CYCLE UNIT PRICES

	<u>No</u> <u>Escalation</u>	<u>6%/</u> <u>Year</u>	<u>7%/</u> <u>Year</u>	<u>8%/</u> <u>Year</u>
Natural Uranium (\$/lb U_3O_8)				
1985	45	68	72	77
1990	56	116	130	147
1995	60	166	196	231
2000	62	230	284	350
2010	64	425	577	781
Enrichment (\$/SWU)				
1985	91	137	146	156
1990	91	189	212	238
1995	91	252	297	350
2000	91	338	417	514
2010	91	605	820	1110
Fabrication (\$/KgHM)-2005				
PWR (UO_2)	177	879	1138	1469
PWR (MOX)	486	2413	3124	4035
CANDU	104	516	668	863
HTGR (makeup)	469	2423	3137	4051
HTGR (recycle)	1413	7014	9080	11717
LMFBR (core)	769	3818	4942	6384
GCFR (core)	842	4180	5412	6990
Reprocessing (\$/KgHM)-2005				
PWR	200	993	1286	1660
LMFBR/GCFR	326	1619	2095	2706
HTGR	720	3575	4628	5977
HLW Disposal (\$/KgHM)-2005				
PWR	62	308	398	515
HTGR	117	581	752	971
LMFBR/GCFR	194	963	1247	1610
Spent Fuel Disposal (\$/KgHM)-2005				
PWR	134	665	861	1112
HTGR	370	1837	2378	3072
CANDU	83	412	534	689

Using the same financial data* assumed in the previous report,⁽¹⁾ discount rates calculated by the above equation and used in this study are as follows:

	<u>Discount Rate (%/year)</u>
Escalation at 6%/year	8.97
Escalation at 7%/year	9.73
Escalation at 8%/year	10.48

It is noted that FUELCOST-V calculates the indirect cost as equal to simple interest on the average balance over the period of energy production at an interest rate equal to the discount rate in order to replicate the discount cash flow approach described in Appendix E to NUS-531.⁽³⁾

3.3 Fuel Cost Effects of Escalation

The 30-year levelized fuel costs presented in Table 3-1 reveal many interesting facts, some of which are discussed below.

1. Compared with unescalated fuel cycle costs (i.e., January 1978 dollars), escalated fuel cycle costs are much greater for those reactor/fuel cycle systems starting operation in later years (e.g., FBRs in 2001) than for systems starting operation in early years (e.g., HTGRs in 1995). While this may be obvious from the standpoint of added escalation (from 1978), it is interesting to "bracket" the extent of fuel cost increases due to escalation. This is done below for 6%/year escalation cases:

*

b(debt fraction) = 0.514
j (debt interest rate) = 0.0693
d (deflator) = 0.03
i (equity interest rate) = 0.10
r (FIT rate) = 0.48

	<u>Fuel Cost Factor*</u>	<u>Start Date</u>
PWR	3.26 - 4.06	1987 - 1991
HTGR	5.17 - 5.24	1995
CANDU	5.28 - 5.46	1995
LMFBR	7.00 - 7.08	2001
GCFR	6.81 - 6.82	2001

* 30-year levelized fuel cost with 6%/year escalation divided by 30-year levelized fuel cost without any escalation.

2. Notice that, at 6%/year escalation, fuel cycle costs increase by a factor of 3 to 4 for PWR (1987 - 1991 startup), 5 to 5.5 for HTGR and CANDU (1995 startup), and 6.8 to 7.1 for GCFR and LMFBR (2001 startup).
3. A careful review of these factors indicate that they may be considered to consist of two factors; escalation from 1978 to the year of startup and escalation beyond the year of startup.

<u>Reactor/Fuel Cycle System</u>	<u>Escalation to Year of Startup</u>	<u>Escalation Beyond*</u>	<u>Composite Factor</u>
PWR-U5 (LE)/U-T	$(1.06)^9 = 1.69$	1.93	3.26
PWR-U5 (LE)+Pu(RE)/U	$(1.06)^{13} = 2.13$	1.91	4.06
HTGR-U5/U/Th-20%-T	$(1.06)^{17} = 2.69$	1.95	5.24
HTGR-U5 (DE)/U/Th-20%	$(1.06)^{17} = 2.69$	1.92	5.17
CANDU-U5 (NAT)/U-T	$(1.06)^{17} = 2.69$	2.03	5.46
CANDU-U5 (SE)/U-T	$(1.06)^{17} = 2.69$	1.96	5.28
LMFBR-Pu/U/U/U-HT	$(1.06)^{23} = 3.82$	1.83	7.00
LMFBR-Pu/U/Th/Th-HT	$(1.06)^{23} = 3.82$	1.85	7.08
GCFR-Pu/U/U/U	$(1.06)^{23} = 3.82$	1.79	6.82
GCFR-Pu/U/Th/Th	$(1.06)^{23} = 3.82$	1.79	6.81

* Composite factors divided by factors for escalation to year of startup.

4. While the first set of factors, i.e., escalation to year of startup, is strictly a function of time, the small difference in factors applicable to escalation beyond the year of startup for a given reactor type is an indication of corresponding difference in fuel cost distributions in early years of operation.
5. In between two escalation rates (e.g., 6 and 7%/year or 7 and 8%/year) the increase in fuel cycle costs is also relatively stable and predictable. Between 6 and 8%/year escalation, the 30-year levelized fuel cycle cost increases by the following factors shown for each reactor/fuel cycle system when the escalation rate is increased by 1%/year:

PWR-U5 (LE)/U-T	1.20
PWR-U5 (LE) + Pu(RE)/U	1.24
HTGR-U5/U/Th-20%-T	1.29
HTGR-U5 (DE)/U/Th-20%	1.29
CANDU-U5 (NAT)/U-T	1.30
CANDU-U5 (SE)/U-T	1.30
LMFBR-Pu/U/U/U	1.35
LMFBR-Pu/U/Th/Th	1.35
GCFR-Pu/U/U/U	1.35
GCFR-Pu/U/Th/Th	1.35

For PWR systems, notice that escalated fuel cycle costs for the recycle case are greater than those for the throwaway case; in other words, the net positive fuel cost benefit associated with plutonium recycle disappears with escalation. This is due to added escalation for the recycle case (additional escalation for 4 years between 1987 and 1991). If both PWR systems are assumed to start in 1991, 30-year levelized fuel costs at 6%/year escalation become as follows:

PWR (throwaway)	\$3.03/MBTU
PWR (recycle)	\$2.68/MBTU

In the case of HTGR for which the startup date is January 1, 1995 for both throwaway and recycle cases, the net positive fuel cost benefit associated with U-233 recycle determined at no escalation still exists with escalation (see Table 3-1).

APPENDIX G

APPENDIX G

BRED FUEL SCENARIOS

The material contained in this Appendix describes some of the methods of costing for the nuclear fuels, U-233 and Pu-239, produced by the operation of both converter reactors and breeder reactors, as used in the reports by NUS Corporation for the EEDB. It consists of the following section extracted from one of the final series* of NUS Corporation EEDB Fuel Cycle reports:

NUS-3190, "Fuel Cycle Cost Estimates for LWR, HTGR, CANDU - Type HWR, LMFBR and GCFR; Section 5.0, "Treatment of Bred Fuel Value."

* Refer also to Appendix "B"

5.0 TREATMENT OF BRED FUEL VALUE

During irradiation inside the reactor, new materials are created in the fuel by the chain reaction process - materials which did not exist when the fuel was loaded into the core. These new fissile materials, once they are extracted from the irradiated fuel, can be used as fuel in the same or some other nuclear reactor. In this case, the material is usually referred to as "bred fuel." The two most common examples of bred fuel are (1) plutonium produced from uranium and (2) U-233 produced from thorium. Neither plutonium nor U-233 are found in nature.

Bred fuels can be recycled into reactors as part of reload fuel and consequently reduce the need for makeup U-235, the only naturally occurring fissile material. In some cases, bred fuel from one reactor can be used as the initial inventory in another reactor, thereby eliminating the startup needs for uranium. If the second reactor is a breeder, it may not even need to use uranium as a fuel. The cost of fuel utilizing bred fissile material is affected by (1) the costs of recovery of the bred fuel from the irradiated fuel, (2) the difference in cost between refabricating bred fuel and fabricating U-235 bearing fuel, if any, and (3) the amount of bred fuel needed to displace U-235 because of the difference in nuclear performance in a given reactor type.

In some reactors the amount of bred fuel is insufficient to maintain operation of the reactor which produced it even if all of it is recycled. For these systems there is always a need for makeup U-235 fuel. Examples of such systems are the light water reactors in wide commercial use today, heavy water reactor of the CANDU type, and high temperature gas-cooled reactors.

In other reactor types the amount of bred fuel produced eventually exceeds that required to sustain operation. For these systems an accumulation of bred fuel occurs which must be stored, sold, used in other reactors, or otherwise disposed of.

A measure of the amount of bred fuel produced compared with the reactor's consumption of fuel is the conversion ratio or breeding ratio. If this ratio is below 1.0, makeup U-235 is always needed to supplement the recycle of the bred material. If this ratio is 1.0 or greater, makeup U-235 is not needed for this purpose. It should be noted that all systems require an initial inventory of fissile material to begin the chain reaction. In practice even systems with breeding ratios above 1.0 will require a few years of operation before becoming self-sufficient on their bred fuel. These systems, therefore, must obtain their initial inventories through a purchase "on the market," through recovery of bred fuel from other reactors, or through some other arrangement.

Recycle "Modes"

A reactor (or a group of reactors) can recycle the bred fuel which it (they) produces in different ways.

A single reactor may recycle all the bred fuel it produces (no more, no less). In this case bred fuel is neither bought nor sold but is retained within the reactor's fuel cycle system. This approach is called "self-generated recycle." If all reactors were to operate on a self-generated mode of recycle, there would be no purchases or sales of bred fuel. That is, there would be no market for bred fuel and no price would exist. Alternatively, a single reactor may sell all the bred fuel which it produces. In this case not all

reactor owners could behave this way since there must be buyers if there are sellers. For example, if the buyer of this bred fuel recycles all the fuel he buys plus what his reactor produces, he is recycling more bred fuel than he himself has produced. This situation is called "open-market recycle." The term "open-market" implies a need for a market to establish a selling price for the bred fuel.

Consider two reactor owners - one selling all the bred fuel produced in his reactor, the other buying all the bred fuel and recycling it plus all that his own reactor produces. Taken together, both reactors recycle bred fuel equal to the sum of what they both produced. The seller of bred fuel receives the same amount of money the purchaser pays. Considering both buyer and seller together, no money is exchanged outside their "system," so there is no change in cost of fuel if both are added together.* It should be noted that if both reactors are owned by the same utility, no exchange of money occurs so there is no change in the cost of fuel to the utility. This makes the "open-market recycle" case look like a "self-generated recycle" case.

5.1 Bred Fuel Value in Fuel Cycle Costs

An important question regarding the calculation of fuel cycle costs for a single reactor is what cost or value to assign to bred fuel. At conversion ratios much below 1.0 the sensitivity of the total fuel cost to the cost or value of bred fuel is usually small. The total fuel cost of a light water reactor which recycles all the plutonium which it produces (self-generated recycle) over many years changes only slightly with the dollar value assigned

* The total cost in terms of millions of dollars will not change. However, the total unit fuel cost in \$/MBTU or mills/kwhe could change because of the difference in physics associated with reactors owned by the seller and the buyer.

to the plutonium. Only if the bred fuel is sold or if additional bred fuel is purchased (open-market recycle), do fuel cycle costs for that single reactor change significantly with the dollar value associated with plutonium.

The lack of sensitivity of the fuel cycle cost to the assumed value of bred fuel in the "self-generated recycle" mode of operation can be understood by noting that no money is spent to buy bred fuel and no income is generated from the sale of bred fuel. The material is simply recycled within the reactor. Therefore, assigning a value to the bred fuel has little effect on the fuel cycle cost. Although a higher value would seem to imply a higher cost for depletion of an asset, this cost is compensated for by a large dollar credit realized when this same material was earlier recovered from spent fuel. For example, if a utility "charges itself" for plutonium when it becomes available to recycle, it should credit itself at the same time for recovery of the asset from fuel previously irradiated. The "credit" exactly cancels the "charge" so the net change in cost is zero.

Following this argument to its conclusion, the only time a credit is received without an offsetting charge in the case of "self-generated recycle" is at the time of reactor decommissioning. At this time, the recovered bred fuel is not recycled further but is available for storage, sale or recycle in some other reactor. Its dollar value at that time, if any, will reduce fuel cycle costs of the reactor which produced it. However, since reactor lifetimes are assumed to be very long and the amount of energy generated over the long time period is very large, the contribution to the levelized fuel cycle cost of this fuel credit is usually small. Of course, if the dollar credit is assumed to be very large, the effect becomes more significant. This circumstance

seems highly unlikely. In fact, if bred fuel is assumed to be equal in value to enriched uranium on a per-gram basis, the impact on costs over 30 years is minimal.

If a reactor owner sells all its bred fuel when it is recovered or buys large quantities of bred fuel rather than U-235 makeup, the total fuel cycle costs will be sensitive to the selling and purchase price of the bred fuel. For systems with a conversion ratio below 1.0, this situation would create a mixture of reactor types - some recycling more than self-generated quantities, others not recycling any material, and others in-between these two extremes. In this case a market for bred fuel (e.g., plutonium) must exist to allow sales and purchases. The market will establish prices which may significantly affect fuel cycle costs of those reactors not on a self-generated mode. Predicting these prices requires predicting the market for bred fuel. This is a very speculative exercise and can lead to a wide variety of results.

The bred fuel value is quoted in relation to the cost of fully enriched uranium (90 to 95 w/o U-235). In the case of plutonium, a parity value is used which is the ratio of the value of a gram of fissile plutonium to a gram of U-235 contained in the fully enriched uranium. In the case of U-233, a parity value is also used, the application of which is defined by the government's formula⁽¹¹⁾ for the value of a mixture of U-233 and U-235 isotope.

5.2 Bred Fuel Scenarios for PWR and HTGR

The bred fuel scenarios selected in this study for PWR and HTGR fuel cycles are described in this section. The parity values used and listed below for plutonium and U-233 were not derived from "indifference" techniques specifically for this study. Instead they represent very preliminary figures based on the results of past work.

	<u>Pu Parity Value</u>	<u>U-233 Parity Value</u>
PWR-U5(LE)+Pu(RE)/U		
Scenario 1	0.5	not applicable
Scenario 2	1.2	not applicable
HTGR-U5(DE)/U/Th-20%	0	1.17

Even though a substantial amount of plutonium is discharged from this HTGR fuel cycle (about 45 kilograms of fissile plutonium per year), a zero parity value was assigned because, in this HTGR fuel cycle, discharged MEU-235 particles are not recycled in mass flows (see Section 6.0, Figure 6-3).

PWR-U5(LE)+Pu(RE)/U

This is the fuel cycle based on the self-generated mode of operation, and the fuel cycle cost is not sensitive to the assumed value of fissile plutonium. As discussed in Section 5.1, the only time a credit is received without offsetting charges is at the time of reactor decommissioning. The contribution of this credit to the levelized fuel cycle cost over a 30-year time period is expected to be small, if not minimal. Nevertheless, two scenarios were selected:

Scenario 1 - The bred fuel value is assumed to be zero, except that the amount of fissile plutonium remaining unrecycled at the time of reactor decommissioning is credited at its value in the light water reactor; a parity value of about 0.5.

Scenario 2 - This scenario is identical to Scenario 1, except that the amount of fissile plutonium remaining unrecycled is credited at its value in fast breeder reactors; a parity value of 1.2.

HTGR-U5 (DE) /U/Th-20%

This fuel cycle is also based on the self-generated mode of operation, and the fuel cost is not expected to be sensitive to the assumed value of bred fuel (plutonium and U-233). Since plutonium is not recovered for recycle in this case, and since the value of U-233 in the HTGR is not expected to be much different from that in the FBR systems, only one scenario was considered for this fuel cycle; the bred fuel value is assumed to be zero, except that the amount of U-233 remaining unrecycled at the time of reactor decommissioning is credited at its value in the HTGR, a parity value of about 1.17.

5.3 Bred Fuel Scenarios for LMFBR and GCFR

Analysis today of a future "breeder system" creates a particular problem because the first or early breeder(s) must have an initial inventory of fissile material in order to sustain operation. For non-breeder reactors, this inventory is enriched uranium for which a market now exists and experience can be used to estimate future trends. For breeder reactors considered in this study, the initial inventory will be plutonium for which no market exists and no experience is available. Furthermore, once breeding is achieved, an excess of bred fuel is created.

It appears as if several situations are possible in the future regarding (i) costs of the initial inventory, and (ii) use of excess bred fuels when they become available. It becomes necessary to develop scenarios for the breeder to investigate how costs are affected by different possible situations which may develop in the future. For this study, a total of three (3) basic scenarios (A, B and C) were selected.

The actual parity values used in this study for plutonium and U-233 are listed below in a summary form:

	<u>Basic FBR Scenario</u>	<u>Pu Parity Value</u>	<u>U-233 Parity Value</u>
LMFBR-Pu/U/U/U-HT			
Scenario 1	A	0	not applicable
Scenario 2	B	0.5 for initial core and zero afterward	not applicable
Scenario 3	C	1.2	not applicable
LMFBR-Pu/U/Th/Th-HT			
Scenario 1	A	0	0
Scenario 2	C	1.2	1.17
GCFR-Pu/U/U/U			
Scenario 1	A	0	not applicable
Scenario 2	B	0.5 for initial core and zero afterward	not applicable
Scenario 3	C	1.2	not applicable
GCFR-Pu/U/Th/Th			
Scenario 1	A	0	0
Scenario 2	C	1.2	1.17

Basic scenarios, A, B, and C are described below.

FBR Scenario A - Industry Self-Generated Recycle

The basic FBR Scenario A applies to the following four (4) reactor/fuel cycle systems analyzed in this study:

- o LMFBR-Pu/U/U/U-HT (designated as Scenario 1)
- o LMFBR-Pu/U/Th/Th-HT (designated as Scenario 1)
- o GCFR-Pu/U/U/U (designated as Scenario 1)
- o GCFR-Pu/U/Th/Th (designated as Scenario 1)

FBR Scenario A assumes that a system of reactors are operating in concert such that bred fuel produced within the system is neither purchased nor sold.

Instead all bred fuel is recycled within the system. With a breeder, this implies that new breeders are initially fueled by operating breeders within the system. Such new breeders are neither charged for plutonium needed nor credited with income for any excess plutonium sold. It is further assumed that at decommissioning no credit is received for the ending inventory of bred fuel.

This situation may be considered to represent the target fuel cost for mature plutonium/uranium breeders in an electrical system containing sufficient excess plutonium from other breeders to start up a new breeder. Note that a new breeder with thorium blankets burns plutonium in the core and creates U-233 in the blanket. This reactor obtains plutonium from some other reactor types such as a uranium/plutonium breeder for its plutonium inventory at no cost (no exchange of money). The U-233 produced in the blanket is then used elsewhere in the system and no income is credited for its sale.

FBR Scenario B - Converter Market Values

The basic FBR Scenario B applies to the following two (2) reactor fuel cycle systems analyzed in this study:

- o LMFBR-Pu/U/U/U-HT (designated as Scenario 2)
- o GCFR-Pu/U/U/U (designated as Scenario 2)

In FBR Scenario B it is assumed that plutonium required for the initial core only is purchased on the market at a value similar to its worth to light water reactors. Any plutonium created in excess of needs is used elsewhere in the system to fuel other breeders at no cost. This simulates the start-up of a breeder with an inventory procured from light water reactor owners but

maintains ownership of bred excess plutonium to start up new breeders a la FBR Scenario A ("no cost" plutonium). This situation might be considered typical of early breeders (LMFBR-Pu/U/U/U and GCFR-Pu/U/U/U) having to compete for purchase of plutonium in a market dominated by light water reactors. As in FBR Scenario A, no credit is allowed at decommissioning.

A plutonium fueled thorium blanket breeder (LMFBR-Pu/U/Th/Th and GCFR-Pu/U/Th/Th) presents a slightly different picture. This reactor burns plutonium and creates U-233. In this case a continued need for plutonium makeup in the core exists. The bred fuel, U-233 produced in thorium blankets, is not recycled back into this breeder's core but is burned in converters. If one assumes that the plutonium comes from LWRs, the quantity of plutonium is limited to that generated by LWRs. This system requires continued purchase of plutonium from LWRs and cannot be compared with the uranium/plutonium breeders in FBR Scenario B on a consistent basis. Therefore, there is no comparable FBR Scenario B for the plutonium fueled thorium blanket breeders.

FBR Scenario C - FBR Market Value

The basic FBR Scenario C applies to the following four (4) reactor/fuel cycle systems analyzed in this study:

- o LMFBR-Pu/U/U/U-HT (designated as Scenario 3)
- o LMFBR-Pu/U/Th/Th-HT (designated as Scenario 2)
- o GCFR-Pu/U/U/U (designated as Scenario 3)
- o GCFR-Pu/U/Th/Th (designated as Scenario 2)

In FBR Scenario C it is assumed that all bred fuel is purchased and sold in the market at a value similar to its worth in a breeder reactor. That is, all

inventories loaded into the reactor at each fueling are purchased and all discharged material is sold after reprocessing. This case does not simulate "self-generated recycle." Instead every breeder pays for its initial inventory until breeding "break even" is achieved at which time the excess quantities are sold to other breeders. The large expense of the initial inventory results in very high costs in the early years. Although selling off of excesses reduces this impact compared with FBR Scenario B, the time lag until these benefits are felt are very long. The net result is that costs are actually greater in FBR Scenario C except for very high gain, low inventory breeders, which may not be possible to design. The reactor/fuel cycle systems studied in this report all show FBR Scenario C as giving the highest fuel cycle costs.

At decommissioning all remaining inventory of fuel is sold at the FBR market value.

In summary, FBR Scenario A is the reference case with the other cases being examples of effects of a market for plutonium. FBR Scenario B can be interpreted as the cost of early breeders taking plutonium from light water reactor fuels for the initial inventory but providing bred plutonium to other breeders which do not share this "start-up" cost. FBR Scenario C is an example of the full "open-market recycle" situation in which the price of bred fuel is established by breeder reactors.