DOE-HTGR-90365

HTGR

MODULAR HIGH TEMPERATURE GAS-COOLED REACTOR COMMERCIALIZATION AND GENERATION COST ESTIMATES

AUTHORS/CONTRACTORS
ABB/COMBUSTION ENGINEERING, INC.
BECHTEL NATIONAL, INC.
GAS-COOLED REACTOR ASSOCIATES
GENERAL ATOMICS
OAK RIDGE NATIONAL LABORATORY
STONE & WEBSTER ENGINEERING CORP.

ISSUED BY GAS-COOLED REACTOR ASSOCIATES
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DISCLAIMER

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LIST OF ACRONYMS & ABBREVIATIONS

ABB/CENP	ASEA Brown Boveri Combustion Engineering Nuclear Power
ACI	American Concrete Institute
AFUDC	Allowance for Funds Used During Construction
AGA	American Gas Association
ALUM	Aluminum
ALWR	Advanced Light Water Reactor
ASME	American Society of Mechanical Engineers
BNI	Bechtel National, Inc.
BSDD	Building and Structure Design Description
BTU	British Thermal Unit
BWR	Boiling Water Reactor
CCCT	Combined Cycle Combustion Turbine
CEC	California Energy Commission
CER	MHTGR Cost Estimate Report
CFR	Code of Federal Regulations
CM	Chrome Moly Steel
COSO	Central Operating Support Organization
CRS	MHTGR Cost Reduction Study
CS	Carbon Steel
CY	Cubic Yards
DC	Direct Cycle
DIA	Diameter
DOE	Department of Energy
DPC	Direct Payroll Related Costs
DV&S	Design Verification & Support
EA	Each
ECA	Energy Conversion Area
EEDB	Energy Economic Data Base
EIA	DOE Energy Information Administration
ENGR	Engineer
EPRI	Electric Power Research Institute
EXP	Exposed
F	Fahrenheit
FDA	Final Design Approval
FOAK	First-of-a-Kind
FSSAR	Final Standard Safety Analysis Report
FY	Fiscal year
GA	General Atomics
GCRA	Gas-Cooled Reactor Associates
GRI	Gas Research Institute
GT	Gas Turbine MHTGR
GT/DC	Gas Turbine Direct Cycle
GT/IC	Gas Turbine Indirect Cycle
Hg	Mercury

LIST OF ACRONYMS & ABBREVIATIONS
(Continued)

IC	Indirect Cycle
IDC	Interest During Construction (also AFUDC)
IEEE	Institute of Electrical and Electronics Engineers
IGCC	Integrated Coal Gasification Combined Cycle
IHX	Intermediate Heat Exchanger
IPP	Independent Power Producer
kg	Kilogram
kV	Kilovolts
kW	Kilowatts
kWe	Kilowatts Electric
kWhr	Kilowatt-Hours
LB	Pounds
LF	Linear Feet
LWR	Light Water Reactor
MHTGR	Modular High Temperature Gas-Cooled Reactor
MMBTU	Million BTUs
MWe	Megawatts Electric
MWhr	Megawatt-Hours
MWt	Megawatts Thermal
NECDB	Nuclear Energy Cost Data Base
NERC	North American Electric Reliability Council
NI	Nuclear Island
NOAK	Nth-of-a-Kind
NPR	New Production Reactor
NRC	Nuclear Regulatory Commission
NUMARC	Nuclear Utilities Management and Resource Council
NUS	Nuclear Utility Services
O&M	operation and maintenance
ORNL	Oak Ridge National Laboratory
PC	Pulverized Coal
PDA	Preliminary Design Approval
P&ID	Piping and Instrument Diagram
PNL	Pacific Northwest Laboratories
PSER	Preliminary Safety Evaluation Report
PSSAR	Preliminary Standard Safety Analysis Report
PWR	Pressurized Water Reactor
QA	Quality Assurance
QC	Quality Control
RM	Reactor Manufacturer
SC	Steam Cycle MHTGR
SCH	Schedule
SDD	System Design Description
SF	Square Feet

LIST OF ACRONYMS & ABBREVIATIONS
(Continued)

SS	Stainless Steel
STR	Structural
SWEC	Stone & Webster Engineering Corporation
SWU	Separative Work Unit
TMI	Three Mile Island incident
TN	Tons
U	Uranium
U_3O_8	Uranium Oxide
UPC	Utility Power Corporation
USCEA	United States Council for Energy Awareness
WBS	Work Breakdown Structure

EXECUTIVE SUMMARY

SCOPE

The goal of the Modular Helium Reactor (MHR) Program (previously identified as Modular High Temperature Gas-Cooled Reactor (MHTGR) as used in the main body of this report) is to establish this technology as a second generation nuclear option that will be attractive to a broad range of owner/operators and meet government and public expectations regarding safety, the environment, and low power costs. With regard to the latter, this report presents estimates for the development, construction, manufacturing and operation of three alternate MHR power plants. The cost estimates are based upon the steam cycle MHR (SC-MHR) Reference Plant design as of September 1992. The direct cycle gas turbine MHR (DC GT-MHR) and indirect cycle gas turbine MHR (IC GT-MHR) cost estimates are based on pre-conceptual designs as evolved through May 1993.

The MHR Reference Plant consists of four 450 MWt reactor modules and four turbine generators. The SC-MHR plant produces a net electric output of approximately 693 MWe, generating 1000°F steam to power conventional steam turbines. The IC GT-MHR produces a net electric output of 806 MWe, generating 1427°F helium through an intermediate heat exchanger to power a closed cycle helium turbine in a secondary loop. The DC GT-MHR produces a net electric output of 869 MWe, generating 1562°F helium directly to a closed cycle helium turbine located in the primary loop.

Costs are developed for the following four MHR plants:

1. A Prototype Lead Module which consists of a single reactor/turbine module with common facilities for the MHR Reference Plant design.

2. A Prototype Plant consisting of the Lead Module above and completion of modules 2, 3, and 4 to complete the first plant conforming to the certified MHR Reference Plant design.

3. A Replica Plant conforming to the certified MHR Reference Plant design that follows the first plant.

4. A Target Plant which is the Nth-Of-A-Kind (NOAK) equilibrium plant (defined by groundrule to be the plant that exceeds 4500 MWe installed capacity) conforming to the certified design.

The commercial operation dates of the completed plants assumed for cost estimating purposes were as follows:

1. Lead Module - January 1, 2007

2. Prototype Plant - January 1, 2012

3. Replica Plant - January 1, 2013

4. Target Plant - January 1, 2016

The construction schedule estimated for the four module Target Plant is 36 months and the overall project schedule is estimated to be 63 months, including a 27 month lead time for manufacturing major vessels and equipment.

APPROACH

The economic performance of the MHR plants has been evaluated using the Advanced Reactor Cost Estimating Guidelines developed by Oak Ridge National Laboratory (ORNL). The purpose of these guidelines is to provide a consistent and comparable basis for advanced reactor cost estimates being developed by the U.S. Department of Energy. These guidelines establish the reference site - the standard EPRI hypothetical East/West Central Site, field labor wage and productivity rates, bulk site material prices, financial parameters, learning assumptions, and common definitions for cost estimate scope.

For comparison purposes, a Target Plant is also defined as the plant which exceeds 4,500 MWe installed capacity. This market size is intended only to place advanced reactor options on a level playing field by prescribing limits to production learning curves rather than reflect a judgement on potential market size. Although actual pricing of initial advanced reactors is likely to reflect a vendor pricing strategy that spreads front-end costs over a minimum series of commercial plant sales, that approach is specifically excluded in the cost estimates presented in this report. The capital cost estimates are intended to be cost based and recover all vendor costs and include a reasonable profit. Table 1 provides a brief summary of the key guidelines.

In addition to providing a framework for developing consistent cost estimates, the guidelines also identify fossil power plant capital and operating costs for comparison and provide reference fossil fuel prices and escalation rates. Alternative plant costs identified in the guidelines and presented herein for comparison were based on a 1992 USCEA report, "Advanced Design Nuclear Power Plants: Competitive, Economical Electricity" and adjusted for consistency regarding interest during construction charges and fuel cost assumptions. The assumed schedule for development, demonstration, and certification of the MHR plant design is shown on Figure 1. This schedule is responsive to the advanced reactor demonstration schedule cited in the Energy Policy Act of 1992.

Capital costs for the reactor plant equipment (excluding vessels, metallic internals and heat exchangers) were developed by General Atomics (GA). Vessel, metallic internal and heat exchanger costs were developed by ASEA Brown Boveri/Combustion Engineering Nuclear Power (ABB/CENP). Costs for the other capital expenditures (equipment, field labor, and field material) necessary to construct the Nuclear Island (NI) were developed by Bechtel. Costs for all the capital expenditures (equipment, field labor, and field material) necessary to construct the Energy Conversion Area (ECA) were developed by

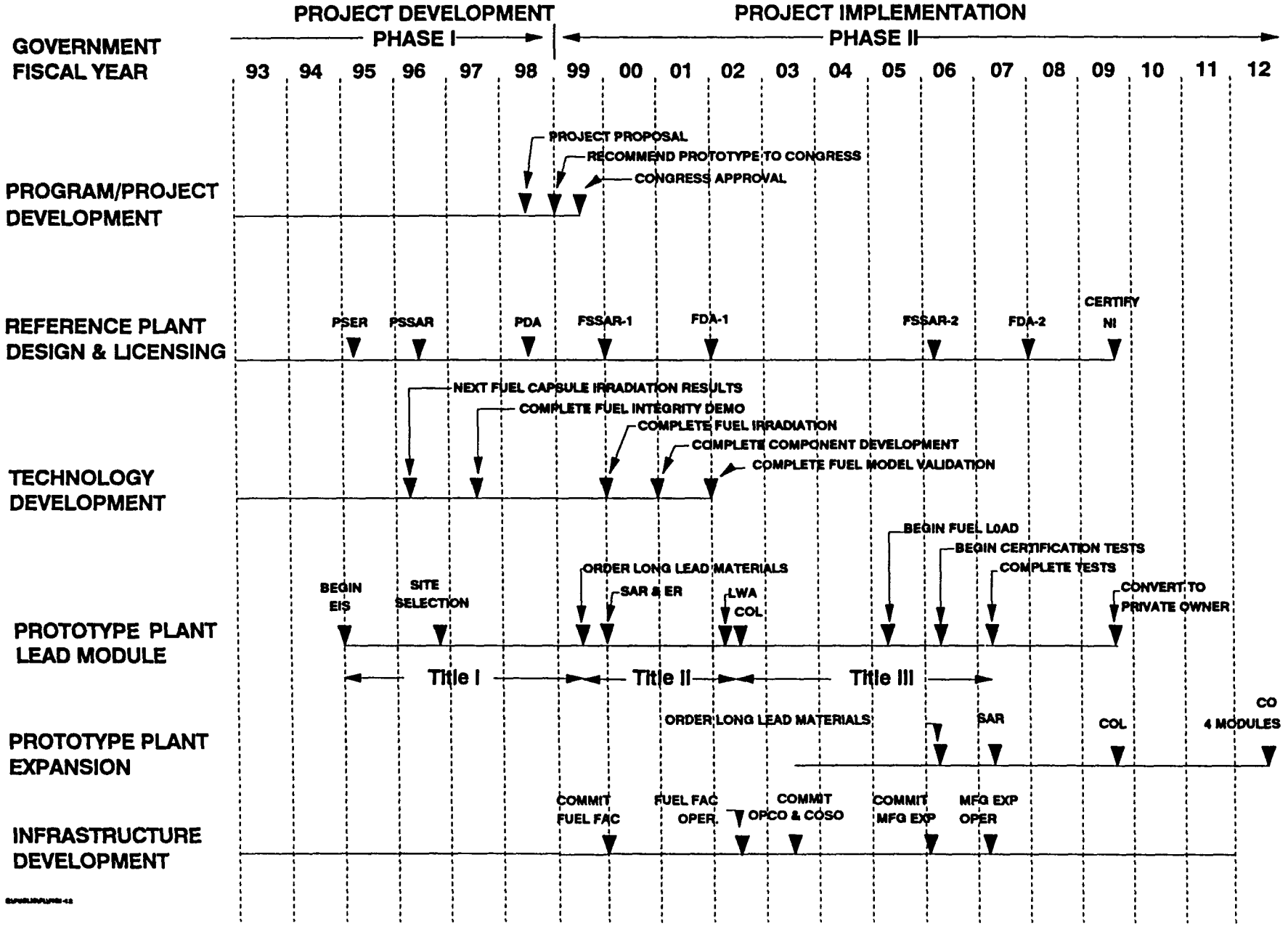
TABLE 1
SUMMARY OF KEY COST ESTIMATE GROUNDRULES

FINANCIAL PARAMETERS		
REFERENCE COST DATE	JANUARY 1992	REAL ESCALATION
FUEL COST INPUT	PRICE	%/YEAR
LWR FUEL PRICE	$0.77/ MMBTU	0.0
COAL PRICE	$1.45/ MMBTU	1.0
NATURAL GAS PRICE	$2.33/ MMBTU	2.2
UTILITY CAPITALIZATION	(%)	RETURN (%/YR)
DEBT	50	9.7
PREFERRED EQUITY	10	9.0
COMMON EQUITY	40	14.0
ECONOMIC PARAMETERS	NOMINAL (%)	REAL (%)
INFLATION RATE	5.0	0.0
CAPITAL/LABOR ESCALATION	5.0	0.0
FEDERAL INCOME TAX RATE	34.0	N/A
STATE INCOME TAX RATE	4.0	N/A
PROPERTY TAX RATE	2.0	N/A
INTERIM REPLACEMENT RATE	0.5	N/A
COST OF MONEY	NOMINAL	REAL
BEFORE TAX	11.35	6.05
AFTER TAX	9.57	4.36
TAX ASSUMPTIONS	NUCLEAR	FOSSIL
DEPRECIATION PERIOD (YRS)	15	20
BOOK LIFE	30	30
DEPRECIATION METHOD	150% DECLINING BAL	
ACCOUNTING METHOD	NORMALIZED	
PRODUCTION ASSUMPTIONS		
TARGET PLANT DEFINITION	PLANT EXCEEDS 4500 MWe	
LEARNING ASSUMPTIONS	94% FACTORY LEARNING	

SITE PARAMETERS		
REFERENCE SITE		KENOSHA, WI
WET BULB TEMPERATURES MAXIMUM		80°F
WET BULB TEMPERATURE FOR ECONOMIC EVALUATION		52°F
SITE LABOR RATES		$/HR
BOILERMAKER		$24.55
CARPENTER		$24.01
ELECTRICIAN		$27.09
IRON WORKER		$27.48
LABORER		$20.94
MILLWRIGHT		$22.47
OPERATING ENGINEER		$25.49
PIPEFITTER		$25.48
TEAMSTER		$16.15
OTHERS		$22.81
SITE MATERIAL COSTS	NUCLEAR	NON-NUCLEAR
FORMWORK	$2.00/SF	$1.85/SF
DECKING	$5.00/SF	$3.00/SF
REINFORCING STEEL	$700/TN	$450/TN
EMBEDDED STEEL	$2.50/LB	$1.50/LB
CONCRETE	$90/CY	$60/CY
STRUCTURAL STEEL	$3100/TN	$1400/TN
MISC. STEEL	$6000/TN	$3000/TN

FIGURE 1
MHR PROGRAM/PROJECT SCHEDULE

11/22/93



Stone & Webster. However, Bechtel prepared the NI and ECA cost estimates for the DC GT-MHR as little incentive remained to retain a separated construction approach. GCRA developed the estimate of the owner's costs (project management, permit fees, taxes, insurance, staff training, etc.) that are incurred before plant startup and included in the plant capital cost, plus integrated the overall estimate, as presented herein.

In addition to base construction, overnight and total capital costs, levelized busbar costs were developed using the methodology presented in the DOE Nuclear Energy Cost Data Base (NECDB) (Reference 5). To develop levelized busbar costs, operation and maintenance costs (O&M), fuel cycle costs and plant decommissioning costs are required in addition to the plant capital costs. These were estimated as follows:

- An updated assessment of operations and maintenance (O&M) costs for the MHR Reference Plant was prepared by GCRA and reviewed by the GCRA Utility Working Group familiar with nuclear generating plant O&M requirements and the MHR design. The O&M costs include the expenses for onsite staff, maintenance materials and supplies, offsite technical support, nuclear regulatory fees, insurance premiums and administrative and general costs.

- Fuel cycle costs were developed by GA based on their fuel fabrication cost estimates and the guideline parameters for uranium, separative work, conversion costs. Spent fuel disposal costs are included at 1 mill/kWhr per the Nuclear Waste Policy Act.

- Decommissioning cost estimates were prepared by Bechtel for three decommissioning scenarios using the actual quantities and commodities used in the capital cost estimate. The decommissioning costs ranged from $120 to $260 million. The reference approach of removal and disposal of all radioactive and removal of all construction material to three feet below grade was estimated to cost $195 million for the SC-MHR and $199 million for the GT-MHR plant designs.

COMMERCIALIZATION AND INITIAL DEPLOYMENT COSTS

Table 2 provides a summary of MHR commercialization and initial deployment costs for the three MHR plant alternatives consistent with the Figure 1 summary schedule. The SC-MHR design is the most advanced and requires the lowest investment, $772 million, in technology and design development to obtain a Final Design Approval (FDA-1) and support construction of the Prototype Plant Lead Module. Development costs increase to $874 million for the IC GT-MHR and $1,013 for the DC GT-MHR which includes a full scale fossil fired test of the power conversion components.

Table 2 also identifies the costs of the Lead Module including common facilities and all operational costs through certification; the completed Prototype Plant through commercial operation, the infrastructure development, including manufacturing and

TABLE 2
MHR COMMERCIALIZATION AND INITIAL DEPLOYMENT COST SUMMARY (1992M$)

	STEAM CYCLE	INDIRECT CYCLE	DIRECT CYCLE
TECHNOLOGY	298	321	422
REFERENCE PLANT DESIGN & LICENSING			
THROUGH FDA–1	459	538	576
NRC STAFF REVIEW THRU FDA–1	15	15	15
SUBTOTAL DESIGN & LICENSING	474	553	591
TOTAL DESIGN & TECHNOLOGY DEVELOPMENT	772	874	1,013
PROTOTYPE LEAD MODULE			
DESIGN & LICENSING	167	172	190
PLANT HARDWARE/CONSTRUCTION	656	769	673
INITIAL CORE + 1ST RELOAD	73	73	73
OWNER'S COST	128	138	201
TESTING/CERTIFICATION COSTS (NET OF FUEL)	33	33	33
SUBTOTAL PROTOTYPE LEAD MODULE	1,056	1,184	1,169
PROTOTYPE PLANT EXPANSION			
DESIGN & LICENSING	84	89	91
PLANT HARDWARE/CONSTRUCTION	974	1,285	985
INITIAL CORES	105	105	105
OWNER'S COST	127	149	129
SUBTOTAL PROTOTYPE PLANT EXPANSION	1,290	1,628	1,310
TOTAL PROTOTYPE PLANT	2,346	2,812	2,479
INFRASTRUCTURE DEVELOPMENT			
FUEL FACILITIES			
PROTOTYPE LEAD MODULE	89	89	89
INITIAL EXPANSION	261	261	261
MANUFACTURING FACILITIES			
PROTOTYPE LEAD MODULE	40	49	40
INITIAL EXPANSION	236	236	237
OWNER/OPERATOR SUPPORT	48	50	50
SUBTOTAL INFRASTRUCTURE DEVELOPMENT	674	685	678
TOTAL COST THROUGH PROTOTYPE PLANT	3,792	4,371	4,170
REPLICA THROUGH TARGET PLANTS	10,212	10,307	8,784
TOTAL COST THROUGH TARGET PLANT	14,004	14,678	12,954

owner/operator support; and the construction of the Replica through Target Plants. Hence, all development costs, plant capital costs through the Target Plant plus the early startup, testing, and certification costs associated with the Prototype Plant are included as initial deployment costs. Note that the strategy of cost sharing of these costs is not addressed. However, the format of results readily accommodates consideration of such.

BUSBAR COST ASSESSMENT

During 1993, the primary cost estimating effort focused on preparing updated capital costs for the reference 4x450 MWt SC-MHR plant design consisting of four reactor modules coupled with four independent steam turbines with net station efficiency approaching 38.5%. In parallel, the on-going MHR gas-turbine evaluation study has defined and evaluated ID GT-MHR and DC GT-MHR plant designs using the same reactor system developed for the SC-MHR plant. The IC GT-MHR design consists of an intermediate helium to helium heat exchanger, a secondary helium loop, and an intercooled helium closed cycle gas turbomachine. The DC GT-MHR design places the gas turbomachine and associated heat exchangers in the primary system, substantially simplifying overall plant design through elimination of secondary systems and associated buildings. Both GT-MHR designs were limited to a core outlet temperature of 1562°F (850°C). The DC GT-MHR net efficiency improved to 48.3% with the addition of intercooling. The IC GT-MHR net efficiency was limited to 44.8% by the reduced turbine inlet temperature caused by the intermediate heat exchanger and secondary loop and the power requirements of the primary helium circulator.

Table 3 provides a breakdown of MHR capital costs for the three MHR concepts described above. Each plant consists of four 450 MWt reactor modules with common facilities. The DC GT-MHR offers the lowest direct plant cost ($825 million) and the highest net electric power output (869 MWe). For all three MHR concepts, structural costs dominate field labor and construction costs. The MHR has less piping and electrical construction relative to other nuclear concepts due to the elimination of active safety systems and reliance on the inherent characteristics of the MHR. The DC GT-MHR, through elimination of the steam and feedwater systems and their auxiliaries has significantly less piping and electrical system requirements as reflected in the Table 3 cost estimates. Total base construction costs range from $1,219 million for the 693 MWe SC-MHR to $1,455 million for the 806 MWe IC GT-MHR and to $1,192 million for the 869 MWe DC GT-MHR.

The updated MHR cost estimates presented have increased relative to prior published estimates due to a combination of design changes and cost estimate guideline changes. The design related changes were dominated by higher structural costs primarily caused by stiffer and stronger reactor buildings, higher reactor plant costs, and higher indirect costs. Contingency is applied to each line item in the cost estimates with the intent of converting most likely estimates into 50/50 confidence level estimates. Total contingency ranges from 19% for the SC-MHR to 24% for the DC GT-MHR. Interest

TABLE 3
MHR CAPITAL AND BUSBAR GENERATING COSTS ('92$)
TARGET PLANTS – 2016 STARTUP

	STEAM CYCLE	INDIRECT CYCLE	DIRECT CYCLE
REACTOR THERMAL POWER (MWt)	4x450	4x450	4x450
NET EFFICIENCY (%)	38.5%	44.8%	48.3%
NET ELECTRIC RATING (MWe)	693	806	869
CAPACITY FACTOR	84%	84%	84%
DIRECT COST ACCOUNTS: (M$)			
LAND & LAND RIGHTS	2	2	2
STRUCTURES & IMPROVEMENTS	150	160	129
REACTOR (BOILER) PLANT EQUIPMENT	423	523	460
TURBINE PLANT EQUIPMENT	156	263	123
ELECTRIC PLANT EQUIPMENT	52	53	53
MISCELLANEOUS PLANT EQUIPMENT	40	40	31
MAIN CONDENSER HEAT REJECTION	30	21	27
TOTAL DIRECT COST	853	1,062	825
INDIRECT COST ACCOUNTS: (M$)			
CONSTRUCTION SERVICES	117	123	98
HO ENGINEERING AND SERVICE	60	63	62
FO SUPERVISION & SERVICE	57	60	46
OWNER'S COST	132	147	161
TOTAL INDIRECT COST	366	393	367
BASE CONSTRUCTION COST (M$)	1,219	1,455	1,192
CONTINGENCY (M$)	232	310	285
TOTAL OVERNIGHT COST (M$)	1,451	1,765	1,477
AFUDC (M$)	176	216	182
TOTAL CAPITAL COST (M$)	1,627	1,981	1,659
UNIT CAPITAL COST ($/kWe)	2,349	2,457	1,910
FIXED CHARGE RATE	9.47%	9.47%	9.47%
LEVELIZED CAPITAL COST (M$/YR)	154	188	157
FIXED O&M COST (M$/YR)	34.6	31.1	27.6
VARIABLE O&M COST (mills/kWh)	0.2	0.2	0.2
CONTROL ROD & REFLECTOR REPLACE (M$/YR)	4.8	4.8	4.8
ANNUAL O&M COST (M$/YR)	40.6	37.0	33.5
FUEL COST ($/MBTU)	1.26	1.27	1.28
LEVEL FUEL CYCLE COST (M$/YR)	56.7	57.6	58.0
DECOMMISSIONING COST (M$)	194	199	199
LEVEL DECOMMISSIONING (M$/YR)	5.2	5.4	5.4
REVENUE REQUIREMENT (M$/YR)	257	288	254
BUSBAR COST (mills/kWh)			
CAPITAL	30.2	31.6	24.6
O & M	8.0	6.2	5.2
FUEL	11.1	9.7	9.1
DECOMM	1.0	0.9	0.8
TOTAL	50.3	48.4	39.7
BUSBAR COST RELATIVE TO TARGET SC–MHR	1.00	0.96	0.79

during construction adds approximately 12% to the total capital cost reported on Table 3.

The IC GT-MHR was evaluated to have the highest capital cost ($1,981 million) and unit capital cost ($2,457/kWe) resulting primarily from the inclusion of the intermediate heat exchanger and secondary helium loop. The SC MHR capital cost was $350 million lower than the IC GT-MHR plant but the lower plant electrical output pushed unit capital costs to $2,349/kWe. The DC GT-MHR had slightly higher capital costs at $1,659 million than the SC-MHR but the higher electrical output dramatically reduced unit capital cost to $1,910/kWe.

Table 3 also presents the 30 year levelized busbar generation costs for the three MHR concepts. The SC-MHR plant has the highest evaluated busbar costs at 50.3 mills/kWhr. A larger O&M staff associated with the steam/feedwater and water treatment systems increased O&M costs relative to the GT-MHR concepts and plant efficiency effects both the O&M and fuel cost components of busbar cost. The IC GT-MHR has a higher capital cost component than the steam cycle but benefits from reduced staffing assumptions and higher net thermal efficiency reducing the busbar cost estimate to 48.4 mills/kWhr, a 4% improvement over the steam cycle. The DC GT-MHR combines the lowest capital cost and O&M staff requirements with the highest plant electrical output leading to a busbar cost estimate of 39.7 mills/kWhr. The DC GT-MHR is 21% lower than the SC-MHR and 18% lower than the IC GT-MHR busbar cost estimates.

Table 4 provides a side by side comparison of the three 4x450 MHR Target plants, a 600 MWe ALWR plant, a 600 MWe pulverized coal (PC) plant, a 500 MWe integrated coal gasification combined cycle (IGCC) plant, and a 500 MWe natural gas combined cycle combustion turbine (CCCT) plant. The reference SC-MHR plant is estimated to cost slightly higher than the fossil alternatives for 2016 startup and nearly 15% higher than the ALWR. The IC GT-MHR plant is projected to be competitive with the fossil options and 10% higher than the ALWR. The DC GT-MHR plant is, however projected to be nearly 20% less expensive than the fossil options and more than 10% better than the ALWR. The busbar cost estimates for Table 4 are presented graphically on Figure 2.

Based on the strong economic incentive and the fact that no feasibility issues were identified in the multi-year GT-MHR evaluation study, the DC GT-MHR was selected as the reference MHR design in mid 1993. Adoption of the DC GT-MHR as the reference also has led to a reexamination of factors limiting reactor thermal output, as the prior steam cycle design was limited primarily by steam generator and main helium circulator considerations. An on-going study is evaluating reactor thermal power levels up to 600 MWt through consideration of higher power density and/or increasing the active core volume. This power level trade study is examining higher power alternatives without increasing reactor vessel diameter or sacrificing any of the MHR passive safety characteristics.

The potential for improved economics is reflected in Table 5 where preliminary estimates for two 600 MWt DC GT-MHR plant configurations are presented and compared

TABLE 4
SUMMARY GENERATION COST COMPARISON ('92$)
2016 STARTUP, TARGET PLANTS UNDER 900 MWe

	MHR TARGET PLANTS			ALWR	COAL		GAS
COST COMPONENTS	STEAM CYCLE	INDIRECT CYCLE	DIRECT CYCLE	USCEA BASED	PC REF	IGCC REF	CCCT REF
o THERMAL RATING (MWt)	4x450	4x450	4x450	1828	1705	2x655	2x550
o NET RATING (MWe)	693	806	869	600	600	500	500
o NET EFFICIENCY (%)	38.5	44.8	48.3	32.8	35.2	38.1	45.4
o NET HEAT RATE (BTU/kWh)	8,868	7,620	7,070	10,400	9,700	8,950	7,514
o CAPACITY FACTOR (%)	84	84	84	80	80	84	84
o # OF TURBINES	4	4	4	1	1	2	2
o SCHEDULE (OVERALL)	60	63	63	60	42	42	24
o SCHEDULE (CONSTRUCTION)	32	36	36	42	30	30	18
o TOTAL CAPITAL (M$)	1,627	1,981	1,659	1,140	836	862	282
o UNIT CAPITAL ($/kWe)	2,349	2,457	1,910	1,900	1,394	1,723	565
o ANNUAL O&M ($/kWe)	58.6	45.9	38.5	64.2	63.2	55.8	12.9
o FUEL COST ($/MMBTU)	1.26	1.27	1.28	0.77	1.45	1.45	2.33
o REAL ESCALATION (%/YR)	0.0	0.0	0.0	0.0	1.0	1.0	2.2
BUSBAR COST (mills/kWh)							
o CAPITAL	30.2	31.6	24.6	26.0	19.4	22.9	7.5
o O&M	8.0	6.2	5.2	9.2	9.0	7.6	1.8
o FUEL CYCLE	11.1	9.7	9.1	8.0	20.3	18.7	39.3
o DECOMMISSIONING	1.0	0.9	0.8	1.0	0.1	0.1	0.0
TOTAL	50.3	48.4	39.7	44.2	48.8	49.3	48.6
OTHER FACTORS (mills/kWh)							
o ENVIR. EXTER. RANGE	~0-1	~0-1	~0-1	~0-2	~2-40	~1-20	~1-8

TABLE 5
SUMMARY GENERATION COST COMPARISON ('92$)
2016 STARTUP, TARGET PLANTS OVER 800 MWe

	DC GT-MHR TARGET PLANTS			ALWR		COAL	GAS
COST COMPONENTS	4x450	3x600	4x600	2X600	1X1200	IGCC 4X250	CCCT 4X250
o THERMAL RATING (MWt)	4x450	3x600	4x600	3,657	3,586	4x655	4x550
o NET RATING (MWe)	869	869	1,159	1,200	1,200	1,000	999
o NET EFFICIENCY (%)	48.3	48.3	48.3	32.8	33.5	38.1	45.4
o NET HEAT RATE (BTU/kWh)	7,070	7,070	7,070	10,400	10,200	8,950	7,514
o CAPACITY FACTOR (%)	84	84	84	80	80	84	84
o # OF TURBINES	4	3	4	2	1	4	4
o SCHEDULE (OVERALL)	63	60	63	78	72	42	24
o SCHEDULE (CONSTRUCTION)	36	33	36	60	60	30	18
o TOTAL CAPITAL (M$)	1,658	1,490	1,830	2,034	1,860	1,611	531
o UNIT CAPITAL ($/kWe)	1,910	1,710	1,580	1,695	1,550	1,611	531
o ANNUAL O&M ($/kWe)	38.5	36.9	32.8	54.5	45.5	50.9	11.2
o FUEL COST ($/MMBTU)	1.28	1.31	1.31	0.77	0.77	1.45	2.33
o REAL ESCALATION (%/YR)	0.0	0.0	0.0	0.0	0.0	1.0	2.2
BUSBAR COST (mills/kWh)							
o CAPITAL	24.6	22.1	20.3	23.2	21.2	21.4	7.0
o O&M	5.2	5.0	4.5	7.8	6.5	6.9	1.5
o FUEL CYCLE	9.1	9.3	9.3	8.0	7.9	18.7	39.3
o DECOMMISSIONING	0.8	0.7	0.7	0.6	0.6	0.1	0.0
TOTAL	39.7	37.1	34.8	39.6	36.2	47.1	47.8
OTHER FACTORS (mills/kWh)							
o ENVIR. EXTER. RANGE	~0-1	~0-1	~0-1	~0-2	~0-2	~1-20	~1-8

FIGURE 2
BUSBAR GENERATION COST BREAKDOWN ('92$)
2016 STARTUP, TARGET PLANTS UNDER 900 MWe

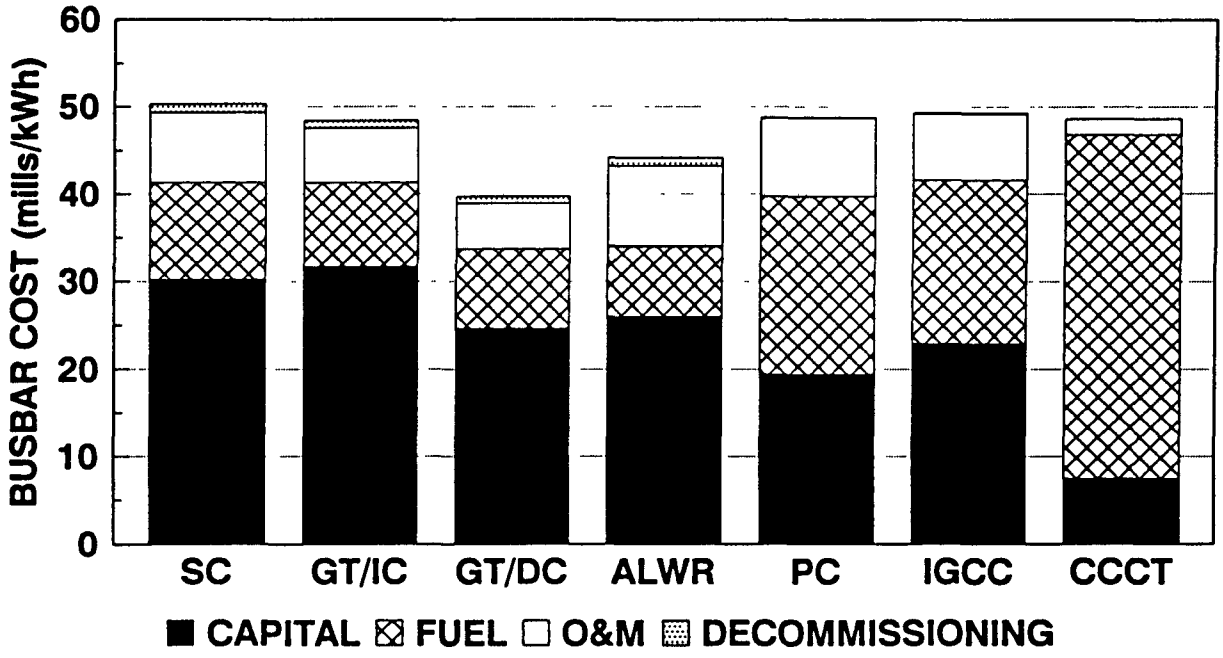
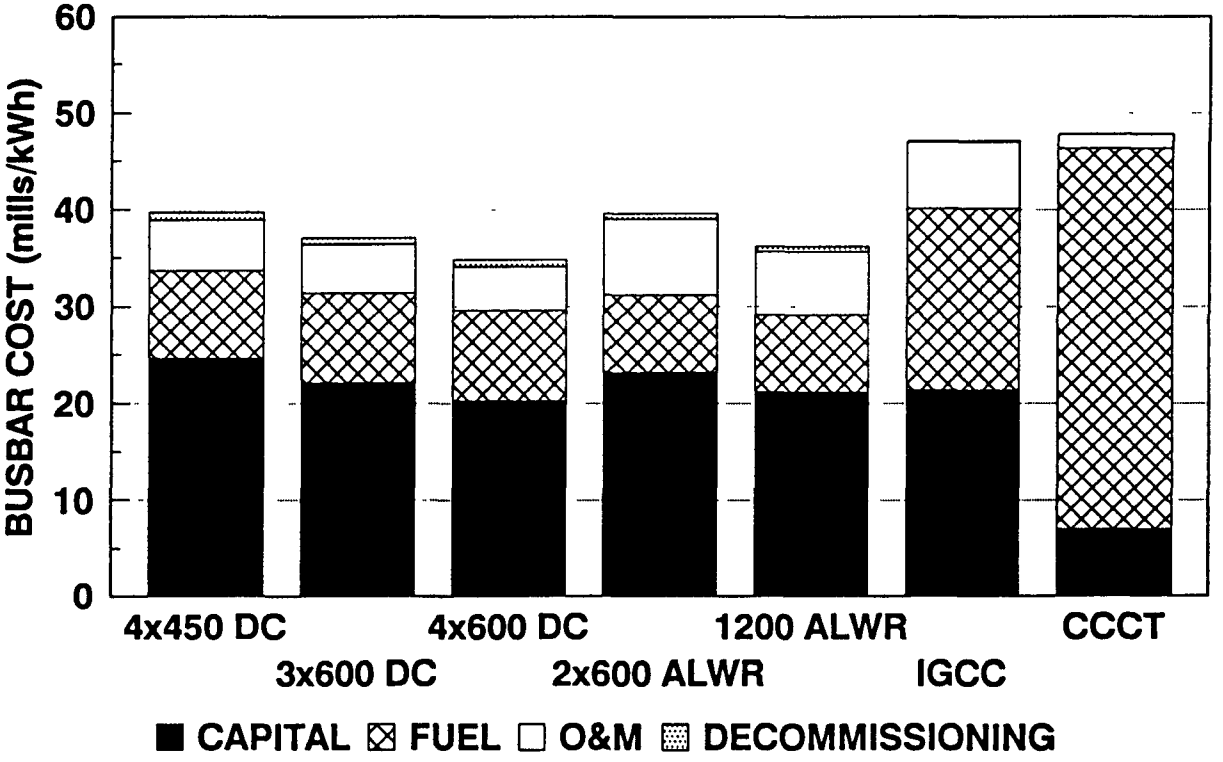


FIGURE 3
BUSBAR GENERATION COST BREAKDOWN ('92$)
2016 STARTUP, TARGET PLANTS OVER 800 MWe



with the 4x450 MWt DC GT-MHR and larger alternative power generation options. Reductions in unit capital and O&M costs for the 3x600 are offset by slight increases in fuel cost leading to nearly a 7% advantage over the 4x450 design. Both GT-MHR plants alternatives compare well with the mid-size alternatives presented on Table 4, showing a 19-24% advantage over the 500 MWe CCCT plant, which is the lowest mid-size fossil cost option. Total 30 year levelized GT-MHR costs are competitive with the 30 year levelized natural gas costs (39.3 mills/kWhr) under the conservative gas price scenario defined.

The 4x600 MWt GT-MHR busbar cost of 34.8 mills/kWhr compares favorably with the 47.1 mills/kWhr and 47.8 mills/kWhr estimated for the 1000 MWe IGCC and CCCT, respectively. The GT-MHR is also projected to be competitive with 1200 MWe ALWR station alternative. Figure 3 provides a bar chart presentation of the large power plant busbar costs presented in Table 5, comparing the 3 large DC GT-MHR plants with 1000-1200 MWe nuclear and fossil alternatives.

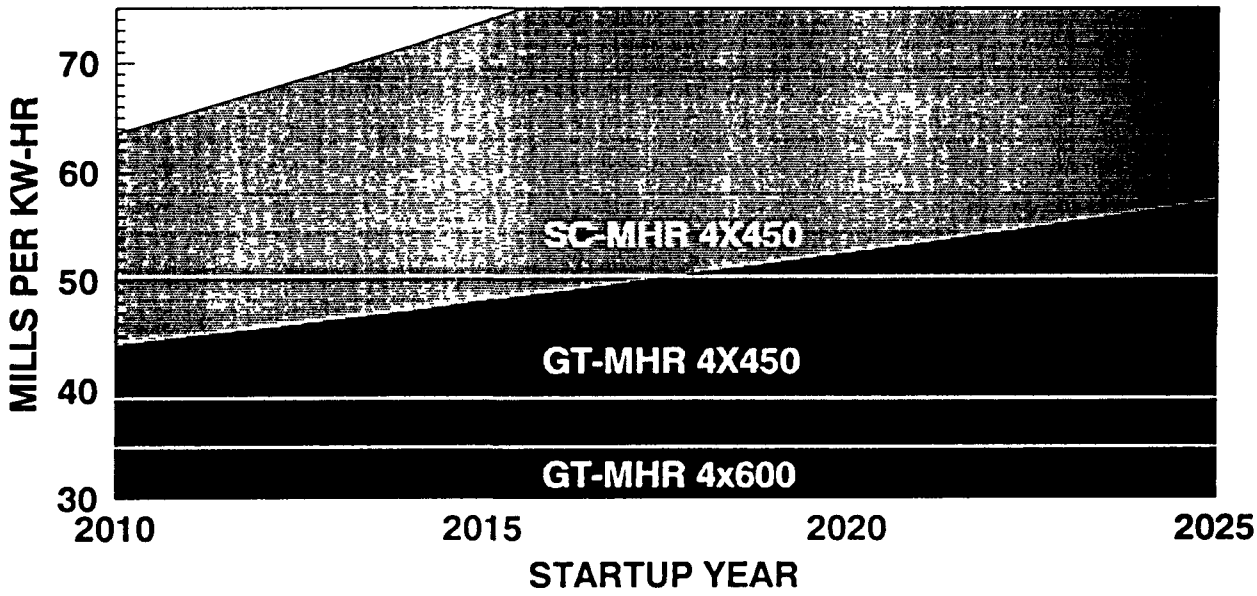
One interesting observation is that the IGCC capital cost component is comparable to the nuclear plants. As natural gas prices increase in the future, nuclear alternatives to IGCC may provide less expensive, more environmentally sensitive options at a comparable capital cost. This would be an appropriate economic goal for advanced reactors. Figures 4 and 5 illustrate the sensitivity of fossil fuel escalation rate assumptions and startup date on the competitiveness of the CCCT and IGCC options, respectively. The MHR groundrules were based principally upon the U.S. Department of Energy 1992 Annual Energy Outlook which contained much lower cost projections for natural gas relative to the 1993 Annual Energy Outlook model which is also shown. Clearly the DC GT-MHR would be a desirable alternative anywhere in the range of 35 to 40 mills/kWhr offered by the 450 MWt and 600 MWt configurations.

Figure 6 provides a graphic comparison of the four DC GT-MHR configurations with the mid-size and large power generation alternatives. Three different stages of the 4x600 DC GT-MHR plant are shown as solid triangles on Figure 6. Although the economic performance is degraded somewhat to less efficient sharing of common facilities, staff, and equipment, the DC GT-MHR remains competitive if only two or three of the planned four module reference plant design are deployed. Thus the individual modules provide an added measure of deployment flexibility over larger nuclear alternatives. As shown, the reference 4x450 DC GT-MHR design is also competitive with alternatives.

CONCLUSIONS

The DC GT-MHR offers the potential for a most attractive advanced nuclear generation option to utilities and power producers of the world early in the 21st century. Although development and demonstration of the technology is required prior to deployment, the forecasted schedule is compatible with current market conditions, particularly in the U.S., that do not favor capital intensive nuclear power alternatives for the foreseeable future. With time, fossil fuel prices and/or restrictions on their use will

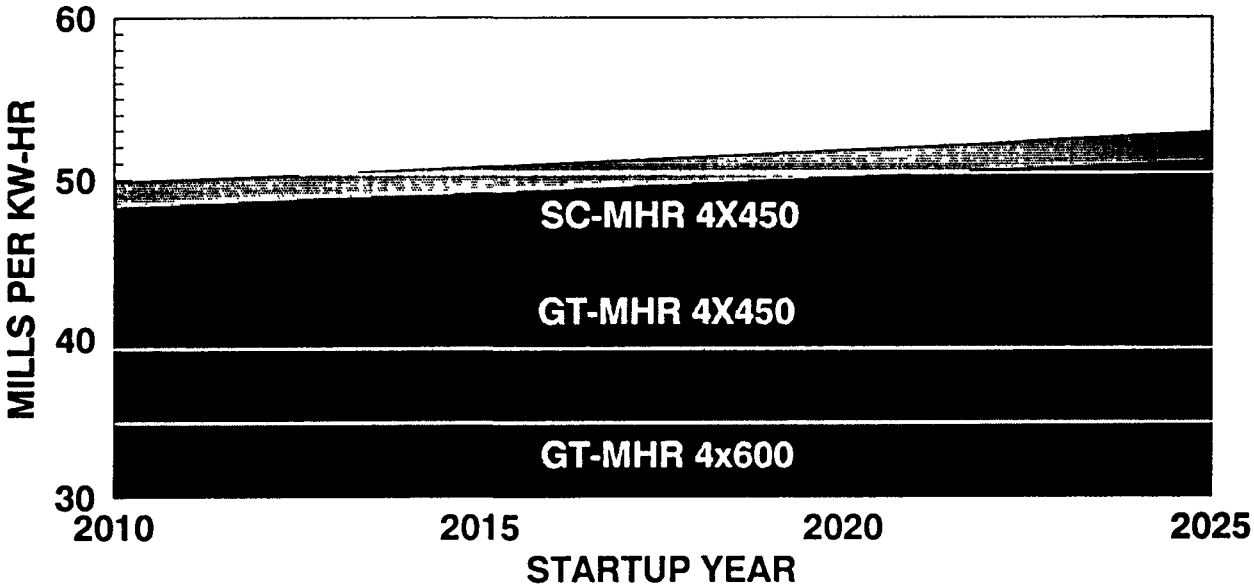
FIGURE 4
MHR TARGET PLANT VS. EIA 1993 NATURAL GAS CCCT
30 YEAR LEVELIZED POWER GENERATION COSTS



■ MHR GROUNDRULES ▣ ANNUAL ENERGY OUTLOOK

ADVANCED REACTOR GROUNDRULES VS. EIA REFERENCE
CASE 1993 ANNUAL ENERGY OUTLOOK

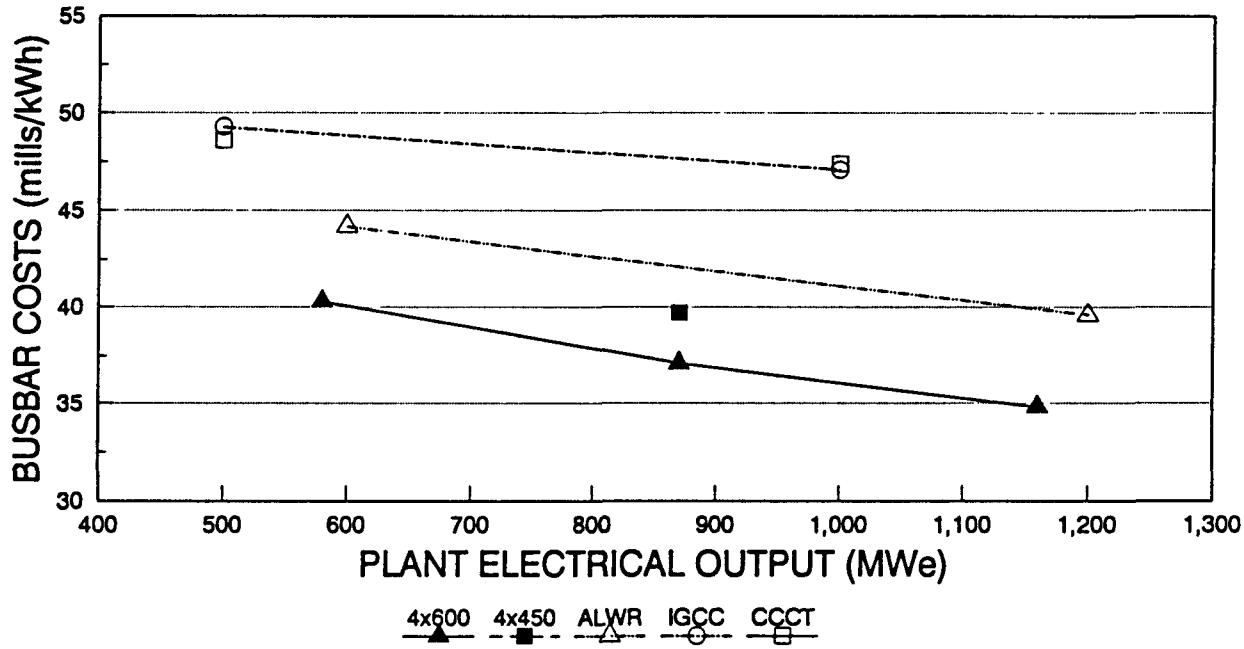
FIGURE 5
MHR TARGET PLANT VS. EIA 1993 COAL IGCC
30 YEAR LEVELIZED POWER GENERATION COSTS



■ MHR GROUNDRULES ▣ ANNUAL ENERGY OUTLOOK

ADVANCED REACTOR GROUNDRULES VS. EIA REFERENCE
CASE 1993 ANNUAL ENERGY OUTLOOK

FIGURE 6
DC GT-MHR VS. ALTERNATE BASELOAD OPTIONS
2016 STARTUP, 30 YR LEVELIZED, EAST/WEST CENTRAL



reopen consideration of advanced nuclear options, if they are available. The DC GT-MHR is an excellent candidate to provide a cost competitive, low risk nuclear alternative for future deployment in the U.S. and abroad and should be advanced.

MODULAR HIGH TEMPERATURE GAS-COOLED REACTOR COMMERCIALIZATION AND GENERATION COST ESTIMATES

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SECTION 1

INTRODUCTION

1.1 BACKGROUND

This report documents the Modular High Temperature Gas-Cooled Reactor (MHTGR) plant commercialization and generation cost estimates as advanced and updated during FY 1993. The previous, comparable cost estimate report was issued in May 1990, Reference 1. The MHTGR cost estimates herein were prepared in accordance with the groundrules and procedures published in Reference 2, and are repeated herein as required to provide a stand-alone report. The groundrules and procedures are in general conformance with the guidelines for advanced nuclear technology cost estimates, Reference 3, prepared by ORNL for the Department of Energy (DOE). These guidelines have been used to develop cost estimates for the MHTGR and ALMR Programs and may be applied to other advanced reactors in the future. Any deviations from the DOE guidelines have been identified by the MHTGR Program participants and are documented in this report.

The baseline estimates reported herein are for the Reference 450 MWt Steam Cycle (SC) MHTGR Plant that is described in the MHTGR Overall Plant Design Specification, Reference 4. This design and configuration was established in 1990 and consists of four reactors coupled with four turbines and associated common facilities producing a net electrical output of 692 MWe. The initial cost estimate for the Reference MHTGR Plant is documented in Reference 5. Significant changes that have been incorporated in the MHTGR design since the May 1990 cost report include the following:

- Increased reactor thermal output by over 28.5% from 350 MWt to 450 MWt
- Thorium fertile fuel has been replaced with natural Uranium
- Conversion from a 2(2x1) plant configuration (two decoupled building blocks, each comprising of two reactors with one turbine-generator) to a 4(1x1) plant configuration (four reactors coupled with four turbine-generators).
- The conventional ACI 318 construction code has been applied for reactor building
- A vented low pressure containment concept has been adopted (with a nominal filter system included in the cost estimate)
- The nuclear island structures strength and stiffness have been increased to accommodate the evolving design of the reactor module

In parallel with the update of the Reference MHTGR-SC Plant cost estimate, two MHTGR Gas Turbine (GT) concepts have been evaluated. The first is an indirect cycle MHTGR-GT, in which the steam generator and steam power conversion cycle are replaced with an intermediate heat exchanger and a recuperated and intercooled secondary gas turbine power conversion cycle. The second is a direct cycle MHTGR-GT, which eliminates the need for a secondary power conversion loop and places the gas turbine power conversion cycle in the primary system. The indirect cycle version is referred to in this report as MHTGR-GT/IC and the direct cycle version is referred to as MHTGR-GT/DC. Much of the MHTGR-SC design is directly incorporated in the two MHTGR-GT designs. However, the net electrical output increases 25% to 869 MWe for the MHTGR-GT/DC and increases 16% to 806 MWe for the MHTGR-GT/IC. An initial evaluation of the MHTGR-GT/DC was initiated in April 1991 and concluded in April 1992. The results are documented in Reference 6. Based upon the recommendations of the initial evaluation, a follow-on evaluation was initiated in late 1992 and concluded in mid-1993. The follow-on evaluation included a refinement of the initial MHTGR-GT/DC design and development of a comparable MHTGR-GT/IC design. Both were compared with the Reference 450 MWt MHTGR-SC. The results are presented in Reference 7.

In addition to the design changes noted above, several groundrules for the cost estimate have also changed, including the reference site. Previous MHTGR cost estimates were based on a generic "Middletown, USA" site located in the northeast. The Energy Economic Data Base (EEDB), maintained by United Engineers & Constructors, used the same reference site through the many updates funded by the Department of Energy (DOE) during the 1980s. Historically, this region has had relatively high craft labor rates, leading to higher capital cost estimates for power plants relative to other regions of the country. The reference site used for this update of the MHTGR cost estimates is a typical East/West Central site located in the Midwest. This region has been referenced previously by EPRI's Technical Assessment Guide, Reference 8, and the 1992 USCEA study, Reference 9. In the USCEA study, actual site craft labor wage rates and productivities were based on the Kenosha, Wisconsin area. Relative to the Middletown, USA site, the East/West Central Site has lower craft labor costs and higher labor productivity.

In the USCEA study, the East/West Central site craft labor wage rates and productivities were based on the Kenosha, Wisconsin area. However, the East/West Central rates recommended by Stone & Webster Engineering Company (SWEC) were based upon Milwaukee, Wisconsin rates, which are somewhat higher. After prolonged discussions among Bechtel (NI), Gas-Cooled Reactor Associates (GCRA), Oak Ridge National Laboratory (ORNL) and SWEC, ORNL elected to adopt the more conservative Milwaukee rates for the DOE Guidelines (Reference 3). As a further conservatism, generic craft labor productivities, based on Bechtel experience, were used rather than the higher craft labor productivities used in the USCEA study for the East/West Central sites.

In prior MHTGR cost estimate reports, capital and generation cost estimates were compared with estimates for Light Water Reactors (LWR) and pulverized coal (PC) power plants that were maintained and routinely updated as part of the EEDB. This provided a consistent set of input assumptions and a solid basis for comparing plant cost estimates.

As updates to the EEDB have not been funded, other sources for competitive plant capital and busbar costs were sought. And, due to significant changes in the economic outlook for natural gas power plants, data for gas-fired combustion turbines were also required for comparison with the projected MHTGR estimates. For the above reasons, the recent USCEA Study (Reference 9) was selected as the source for pulverized coal (PC), and natural gas combined cycle combustion turbine (CCCT) cost estimates.

A statement of the cost estimate scope is provided in Section 1.2 followed by a summary of the groundrules and assumptions in Section 1.3. An outline of the approach used in FY 93 for the preparation of the estimates is given in Section 1.4 and definitions of the more pertinent terms used in the cost estimate are given in Section 1.5. The account structures used for the cost estimates are contained in Section 1.6. Design and technology costs are discussed in Section 2. Plant capital cost estimates for the MHTGR-SC, MHTGR-GT/IC, and MHTGR-GT/DC are presented in Sections 3, 4, and 5, respectively. Commercialization costs for the three concepts are presented in Section 6 followed by generation cost comparisons in Section 7. Selected sensitivities and a discussion of the overall results are given in Section 8. References are listed in Section 9.

1.2 MHTGR COST ESTIMATE SCOPE

The scope of the MHTGR cost estimate update prepared in FY 1993 includes all costs to design, build and operate MHTGR power plants based on the Reference 450 MWt MHTGR-SC Plant design baselined through the Overall Plant Design Specification, Reference 4. In addition, comparable cost estimates have been prepared for the MHTGR-GT/IC and MHTGR-GT/DC concepts. Updated estimates are presented for the following (refer to Section 1.5 for definition of terms):

1. Technology Development (R&D) Costs
2. Reference (Standard) Plant Design Costs
3. Prototype Facility (Lead Module) and Test Costs
4. Reference (Standard) Plant Certification Costs
5. Standard Fuel Facility Costs
6. First-of-a-Kind (FOAK) Equipment Costs
7. Other Infrastructure Costs
8. Prototype Plant (Lead Module + 3 Expansion Modules) Cost
9. Replica Plant Cost
10. Target (NOAK) Plant Cost

For the purpose of preparing the cost estimates, the commercial operation dates to be assumed for the completed plants are:

1.	Lead Module	-	January 1, 2007
2.	Prototype Plant	-	January 1, 2012
3.	Replica Plant	-	January 1, 2013
4.	Target Plant	-	January 1, 2016

Table 1-1 provides a reference schedule for the commercial deployment of the MHTGR between 2010 and 2016 and is intended to provide a basis for developing the Replica and Target Plant cost estimates and the sizing of initial production facilities. It is recognized that the potential market for the MHTGR may be significantly larger than shown on Table 1-1, especially when the international market is considered. However, expanded markets are more likely to be supplied through multiple regional facilities as U.S. and international markets develop.

Figure 1-1 provides a summary project schedule for the development and deployment of the MHTGR Prototype Plant, consistent with the Energy Policy Act of 1992. The key bases of this deployment scenario are highlighted below:

- Through 1998, the Government primarily funds the Technology and Design Development Program to achieve commitment for a cost shared Prototype Plant.

- For FY 1999 and beyond, a joint Government/Private Sector Prototype Plant is built on Government reservation.

  - Government funding completes Technology Development Program

  - Joint Government/Private Sector funding completes Design Development Program through Design Certification

  - Government funds Lead Module with common facilities built, tested, and operated through Design Certification.

  - Private Sector purchase/takeover of Lead Module and decision to deploy Modules 2, 3, and 4 of Prototype Plant upon successful Certification Test Program and receipt of commercial orders for at least 6 additional plants.

- Private Sector provides the investment in infrastructure and manufacturing facilities to support deployment of a series of identical commercial MHTGR power plants.

  - Commercial MHTGR power plants are identical to the Prototype Plant except for elimination of special test equipment and instrumentation provided on Lead Module for testing and monitoring associated with Design Certification.

  - Scope of supply for each plant is identical, with only the absolute minimum design modifications to accommodate site specific conditions such as:

    - Location and source of water supply
    - Location of railroad spur
    - Site topography and elevation at grade
    - Location of switchyard, generator step-up transformer and transmission lines
    - Soil conditions that affect excavation

- The initial series of commercial MHTGR power plants will include, at a minimum, the 27 modules required to complete the Prototype Plant, and build the Replica through Target Plants. The Vendor/Constructor Team will have prearranged supplier agreements to provide identical equipment, instruments, cables, etc., taking advantage, where possible, of quantity discounts for the series of plants and avoiding the competitive bidding process on each individual plant in the initial series.

- Each plant will be provided to the customer on a turnkey basis. The Vendor is responsible for post construction system checkout, test, and demonstration using, where possible, Operator personnel provided under the Owner's Cost Account. Vendor turns over all plant systems to Operator in time for Fuel Load. Operator directs Fuel Load and integrated plant startup, low power testing, and power ascension, using operating personnel with technical support from Vendor personnel.

- Commercial offering and deployment is based on successful deployment and startup of the Prototype Plant Lead Module. A critical mass of customer orders, presumed to be equal to or greater than the six (6) new power plants required to reach the Target Plant, are received. The Vendor Team invests the additional resources necessary and develops supplier arrangements to provide the scope of supply for the multiple orders in an efficient and cost effective manner.

- Changes due to customer preference and design optimization may be expected but are not included in the scope of supply or the plant capital cost estimate and would be considered a change order to the standard plant offering.

The estimates for the technology and design costs were prepared using the HTGR Program Work Breakdown Structure (WBS) and the plant capital costs were developed using the Department of Energy (DOE) Energy Economic Data Base (EEDB) Program code of accounts, as adapted to the MHTGR plants. The WBS Structure and EEDB Codes of Accounts are detailed in Appendices A and B respectively. The EEDB code of accounts allows a comparison between the MHTGR plant capital cost estimates and costs of other plants reported in the EEDB format.

In addition to the plant capital costs, levelized total busbar generation costs were developed and compared with comparably sized, clean coal and combined cycle gas turbine plants. The levelized busbar generation costs were developed using the methodology presented in the DOE Nuclear Energy Cost Data Base (NECDB), Reference 10.

1.3 GROUNDRULES AND ASSUMPTIONS

This section describes the major groundrules and assumptions that support the scope of the MHTGR cost estimates.

1. All cost estimates are reported in constant January 1992 dollars.

2. The base construction cost estimates presented are the most likely costs without interest, escalation, or contingency allowance. The capital cost estimate with contingency is to represent a 50% confidence estimate, where there is an equal probability that the ultimate cost is higher or lower.

3. Any assumed use of any government-owned or -operated facility was estimated at full cost recovery, including all direct costs, allocable indirect costs, depreciation, and any other related general and administrative costs. Costs for use of these facilities, if any, were obtained from DOE-NE by the program participant responsible for that cost element.

4. All construction and installation costs reflect a physically separated construction concept whereby nuclear-grade and Seismic Category I construction are separated from industrial-grade (non-nuclear) construction. All costs of equipment, materials, storage, quality assurance (QA), quality control (QC), and labor productivity for the non-nuclear areas reflect conventional commercial industrial-grade practice. Note, this physical separation may no longer be necessary as the MHTGR design of all structures is now based on the ACI 318 construction code. Installation of a limited number of nuclear-grade piping, electrical, and instrumentation systems may be managed effectively without the separated construction concept. However, the current design and cost estimate includes additional quantities to maintain this separated construction approach.

5. As an aid in establishing system-to-system boundaries for estimating purposes, the following general guidelines were used:

   a. The cost estimate for a system, equipment, facility, or structure includes those costs associated with designing, fabricating, installing, and/or constructing the particular items described in the System Design Descriptions (SDDs), or Building and Structure Design Descriptions (BSDDs).

   b. For estimating purposes, the boundaries of a system, facility, or structure are defined in the SDDs or BSDDs and in the piping and instrumentation diagrams (P&IDs).

   c. The cost for all electrical power terminations, including connectors, are borne by the electrical power system. For building service power and lighting systems, the interface with the electrical power system is the individual power lighting panel.

d. The expense for terminating instrumentation and control cabling and wiring, with the exception of control system fibre optics cabling, is also included in the electrical power system. This includes terminations with individual sensors, as well as providing electrical interconnections between panels, cabinets, consoles, data processing units, controllers, etc. The expense for terminating the control system fibre optics cabling is included with the control system.

e. Costs for routing and laying or pulling wire and cable in ducts, conduits, and trays are included in the electrical power system.

f. The costs for attachments to structures (e.g., anchor bolts and auxiliary steel) are borne by the equipment item requiring the support. Embedments are included in the costs of structures.

8. Assumptions regarding the organizational structure used in developing the cost estimates are as follows:

   a. Overall project management is provided by an owner entity.

   b. A vendor entity is responsible for the engineering and design, licensing support, manufacturing and construction management activities for the plant.

   c. Equipment manufacture and plant construction for all the plants (Lead Module, Prototype, Replica, and Target) are performed by the same vendor/contractors.

9. The Prototype Plant cost estimate is based on the assumption that changes expected to the NRC regulations and major codes and standards (e.g., ASME or IEEE) by virtue of the Reference MHTGR design concept are obtained.

10. The Replica and Target Plant cost estimates are based on the assumption that the plant design is identical to the Prototype Plant (i.e., no product improvements are incorporated and no changes are made to regulations, codes and standards) and that the NI design has been certified.

11. Learning cost reductions for new factory produced items are based on a 94% unit learning curve (reduced cost % for each item doubling). Learning is applied for estimating individual factory produced components, systems or "modules" with the starting point being the first equipment item for the Prototype Plant. For the Target Plant, it will be assumed that the cumulative manufacturing production is at or in excess of 4500 MWe (i.e., the 7th plant containing the 25th, 26th, 27th, and 28th reactor modules and turbine generators for the Reference MHTGR Steam Cycle). The learning cost reductions shall apply only to items which are not currently available on a commercial basis. The default 94% learning curve is intended to apply to the combined labor and material portions of equipment cost.

12. Learning cost reductions for field labor are based on a 97% learning curve for the same site (assuming the reference optimum deployment sequencing). A 98% learning curve is applied for field labor on a site-to-site basis.

13. The estimates assume that all engineering information, including specifications and drawings, is released for construction in time for efficient planning and performance of the work and that all equipment, material, and labor resources are available as required and there are no funding constraints.

14. The plant cost estimates are based on the MHTGR construction schedules for the MHTGR Prototype and Target Plants included in Appendix D. These schedules are based on the optimum use of field labor for slide-along construction practices.

15. A rolling 4 x 10 hr. day, 70 hr. site construction work-week is used when dictated by the construction schedule. A small premium was included for the rolling 4 x 10 work week, which partially offsets improvements in labor productivity assumed for the rolling 4 x 10 work schedule. Rolling 4 x 10's were not used for the Lead Module or Prototype Plants but were required to meet the schedule assumptions for the Replica and Target Plants.

16. Site land is based on a cost of $10,000/acre per Reference 3. It is assumed that the total land cost is incurred at the same time as the decision is made to build a plant (i.e., start of site-specific design). Per the Utility/User requirements, Reference 11, which require the MHTGR design to preclude offsite evacuation and sheltering for a site radius of 425 meters, the associated land requirement is 200 acres. This is lower than the 500 acres specified in Reference 3 which are applicable for other advanced reactors.

17. Site construction labor crew composition and wage rates are provided for the East/West Central USA in Table 1-2 (base rate plus fringes). A listing of structural, piping, and electrical bulk commodity costs are provided in Table 1-3 for nuclear and non-nuclear construction grades. Installation manhour rates for these bulk commodities are provided in Table 1-4 for both nuclear and non-nuclear construction grades. The commodity prices are based on recent power plant experience. The installation manhour rates are based on BNI's pre-TMI experience. The definitions for the commodity items presented are included in Table 1-5.

    The craft labor rates used to develop the crew composite wage rates were based on published union rates for Milwaukee, Wisconsin for January 1992. Actual labor rates used for the nuclear power plant estimates contained in the USCEA Study (Reference 9) were discovered to be lower, on average, than the estimates contained in Table 2-1. This is apparently due to differences in union labor rates between Kenosha and Milwaukee.

    Based on recommendations from BNI and with concurrence from Stone & Webster (SWEC), labor productivities are based on the recently enacted Bechtel National

Labor Alliance. A 10% increase in the number of manhours was assumed for the Lead Module, which is consistent with the productivities identified in Table 1-4. For the Replica and Target Plants which employ rolling 4 x 10 work schedules, an additional reduction of 5% was included to account for productivity improvements associated with the 10 hour work day, net of premium pay.

18. Any factory fabricated (on-site or off-site) modules assumed factory wage rates for factory crafts to be comparable with the Table 1-2 field labor rates. The total module cost excluding field labor to install is entered as an equipment item.

19. The costs in all cost categories, including the development costs, represent costs to the buyer and include nominal supplier profit margins.

20. Financial parameters for plant and facility capital cost estimates is provided in Table 1-6 for the utility, industrial, and highly leveraged entity cases. The financial structure and cost of money shown were incorporated into the interest during construction calculations. Table 1-7 identifies the fixed charge rate parameters for the three cases. The MHTGR capital cost estimates developed were based on utility ownership of the MHTGR power plant and industrial ownership of manufacturing and fuel production facilities.

21. Nuclear fuel cycle cost assumptions utilized in the development of MHTGR fuel cycle costs are listed in Table 1-8. Fossil fuel cost assumptions are listed in Table 1-9.

1.4 MHTGR COST ESTIMATE APPROACH

The following outlines the approach for developing the MHTGR cost estimates:

1. Technology and design cost inputs were provided by MHTGR Program participants in those areas for which they have lead responsibility. Technology and design costs are structured in accordance with the MHTGR Program Work Breakdown Structure. Specific responsibility for the Technology and Design Development cost estimates are itemized in Reference 2, Appendix B, Table B-1.

2. Plant base construction cost, contingency and cash flow inputs have been provided by MHTGR Program participants in those areas for which they have lead responsibility. Cost inputs are structured in accordance with a modified version of the EEDB Code of Accounts as described in Section 1.6.2 and listed in Appendix B.

3. To facilitate development of base construction, contingency and cash flow cost inputs, the following steps were taken as further detailed in Reference 2:

a. The Description of Work (DOW) statement for each item was updated by the responsible participant to delineate the scope, boundary and technical basis for cost estimating. The updated DOW's were exchanged between the Program participants to insure that all plant items are covered and that there are no overlaps. The DOW's which detail the scope and basis for the MHTGR-SC cost estimate have been compiled and issued as Reference 12.

b. Capital cost input was updated by participants and provided to Gas Cooled Reactor Associates (GCRA) in spreadsheet form in accordance with the cost estimate responsibilities delineated in Reference 2, Appendix B, Table B-2.

4. Using the methodology described in References 2 and 3, GCRA has integrated base construction cost and total capital cost estimates for the Lead Module, Prototype, Replica and Target Plants. Development of estimates for the Prototype, Replica and Target Plants were based upon learning factors as prescribed in References 2 and 3.

5. Updated owner's cost estimates were developed by GCRA based on input from participants, the utility working group, and the groundrules detailed in References 2 and 3. The owner's cost estimates are presented in detail in Reference 13.

6. Updated operations and maintenance (O&M) cost estimates were developed by GCRA, using input from other participants and the utility working group. The details of these O&M estimates are reported in Reference 14.

7. Updated fuel cycle cost estimates were developed by GA, in accordance with the groundrules detailed in References 2 and 3.

8. Busbar generation cost estimates for the Prototype, Replica and Target Plants were developed and presented in this report in accordance with the methodology specified in References 2 and 3.

1.5 DEFINITION OF TERMS

The following summary definitions are provided to define key terms used throughout this document.

1.5.1 Technology Development (R&D) Costs

Costs associated with material, component, system, process and fuel development and testing performed specifically for the MHTGR design concept.

1.5.2 Reference (Standard) Plant Design Costs

Costs associated with the engineering and engineering support functions for the design and licensing of the standard MHTGR plant through the FDA-1 (See Figure 1-1). Design and licensing of the Standard Nuclear Island Design beyond FDA-1 are included under Reference Plant Certification Costs below.

1.5.3 Lead Module (Prototype Facility) and Test Costs

Costs specific to the Lead Module of the Prototype Plant. These costs include the Lead Module specific design, development, licensing, construction, and testing to support the design certification. The reference deployment scenario for the MHTGR does not include a requirement for a separate prototype test facility.

1.5.4 Reference (Standard) Plant Certification Costs

Costs associated with licensing after the FDA-1 through certification of the Standard MHTGR Nuclear Island Design.

1.5.5 Standard Fuel Facility Costs

Costs associated with the design and construction of any fuel facility, including the equipment, equipment proof testing, and licensing.

1.5.6 First-of-a-Kind (FOAK) Equipment Costs

Costs for the development of manufacturing specifications, factory equipment, plus the startup and tooling of factories that are used for manufacturing specific equipment for the MHTGR Prototype Plant.

1.5.7 Other Infrastructure Costs

Costs associated with establishing a vendor/supplier and owner/operator infrastructure to supply, operate, and support commercial operation of the MHTGR Prototype Plant, exclusive of the Fuel Facility and FOAK Equipment costs identified above.

1.5.8 Total FOAK Costs

All first-of-a-kind costs necessary to put a Prototype Plant in place and to obtain NRC certification of the standard nuclear island which will not be incurred for subsequent plants. Such costs include the technology, design, testing and certification and FOAK equipment costs, noted above.

1.5.9 Prototype Plant Costs

Prototype Plant costs include all FOAK costs plus site-specific engineering and licensing along with the Prototype Plant equipment, materials, construction, startup, project management, and other costs required for owner acceptance. For the FY 1993 cost update, no consideration was given to deployment of a preceding New Production Reactor application of the MHTGR. For the Reference MHTGR deployment scenario, the Prototype Plant is the Lead Module with complete common facilities expanded to the Standard MHTGR configuration of four reactors and four turbines. The Prototype Plant costs reflect the learning associated with building 3 additional reactor/turbine modules identical to the Lead Module, except for any unique instrumentation required for the certification testing program.

1.5.10 Replica Plant Costs

The Replica Plant is the second plant of identical design to the Prototype Plant. The Replica Plant costs include all site-specific engineering and licensing, equipment, construction, startup, project management, and any other costs that are repetitive in nature and would be incurred in building subsequent plants of the identical design. The Replica Plant costs also reflect the learning associated with building a second plant identical to the Prototype Plant. For the Reference MHTGR deployment scenario, the Replica Plant is the first fully commercial plant.

1.5.11 Target Plant Costs

The Target Plant is the nth-of-a-kind (NOAK) or equilibrium commercial plant of identical design to the Prototype Plant. The Target Plant costs include all site-specific engineering and licensing, equipment, construction, startup, project management, and any other costs repetitive in nature that would be incurred in building identical plants. The Target Plant reflects the learning experience associated with the construction of 4500 MWe of installed MHTGR capacity using fully loaded, state-of-the-art facilities for MHTGR specific materials and equipment. For the MHTGR-SC, the Target Plant is the seventh (7th) four module plant (25th through 28th reactor). For the MHTGR-GT concepts, the Target Plant is the sixth (6th) four module plant (21st through 24th reactor).

1.5.12 Base Construction Cost

The base construction cost is the plant capital cost consisting of the direct and indirect costs, but excluding contingency, interest, and escalation and owner's discretionary items. The direct costs are associated with the equipment and structures that comprise the complete power plant. The indirect costs are expenses for services applicable to the plant, such as the site-specific home office engineering and design, field office engineering and services, and owner's costs.

1.5.13 Contingency Costs

Contingency cost is a judgement adder to the "most likely" cost estimate to obtain an "expected or median" cost estimate. Contingency provides an allowance for cost (and, at present, design) uncertainties including an allowance for indeterminates. Contingency cost does not include any allowance for potential changes from external factors such as government regulations, major design changes, catastrophic events, labor strikes, extreme weather conditions, varying site conditions, or project funding (financial) limitations. Contingency is applied to plant direct and indirect capital costs. All other estimates are provided as 50/50% confidence values. See Reference 2, Appendix C for an expanded discussion of "most likely", "expected", and Contingency costs.

1.5.14 Total Overnight Cost

The total overnight cost is the base construction cost plus applicable contingency costs. It is referred to as an overnight cost in the sense that time value costs such as interest during construction are not included.

1.5.15 Escalation

Escalation is a change in cost greater or less than general inflation as measured by the Gross Domestic Product Implicit Price Deflator.

1.5.16 Total Capital Cost

The total capital cost is an all inclusive plant capital cost developed for the purpose of calculating the plant busbar electricity cost. This cost is the base construction cost plus contingency, escalation, and interest related costs.

1.5.17 Constant Dollars

Constant dollar cost is defined as the cost for an item measured in dollars that have general purchasing power as of some reference date. As inflation is generally associated with the erosion of the general purchasing power of the dollar, constant dollar analysis is said to exclude inflation.

1.5.18 Nominal Dollars

Costs including inflation are given in nominal dollars (also referred to as "current" dollars, "year of expenditure" dollars or "as-spent" dollars).

1.5.19 Nominal Cost of Money

The nominal cost of money is the percentage rate used in calculations involving the time value of money containing an inflation component. It explicitly provides for a return on an investment over and above a real return to keep up with inflation.

1.5.20 Real Cost of Money

The real cost of money is the percentage rate used in calculations involving the time value of money when the inflation component has been removed. Calculations using the real cost of money assume that the dollar maintains a constant value in terms of purchasing power and, thus, no return on an investment is needed for inflation.

1.5.21 Materials

Materials include field-purchased (site material) and/or bulk items such as lumber, reinforcing, concrete, structural steel, and plumbing items. All piping less than 2-1/2" diameter is a materials item with the exception of pipe for cryogenic fluids, which is an equipment item. Also, all wire, cable and raceways, with the exception of fibre optic control cables, are material items, including those in building service power systems.

1.5.22 Equipment

Generally, equipment includes all manufactured items including pipe greater than 2-1/2" in diameter and all cryogenic system pipe. Such items may be procured on a design-and-build contract from qualified suppliers, wherein design responsibility belongs to the supplier, or the design responsibility may be maintained by the MHTGR vendor entity on a so-called "build-to-print" basis.

1.5.23 Force Account

Force account involves the direct hiring and supervision of craftsmen to perform a construction activity by a prime contractor as opposed to the prime contractor hiring a subcontractor to perform these functions.

1.5.24 Construction Module

A construction module is a free-standing transportable preassembly of a section or portion of the plant. A construction module may be a preassembly of a single system or portion thereof or may contain elements of all the systems that exist in a given geographical location of the plant. A construction module may even contain parts of the building structure. A construction module would typically be assembled in a factory, shipped to the plant site and installed with a minimum of operations.

1.5.25 MHTGR Standard Reactor Module

A standard reactor module is that portion of the nuclear island which is duplicated with the addition of each reactor.

1.5.26 MHTGR Reference (Standard) Plant

The MHTGR Reference Plant consists of four standard reactor modules and four turbine generators with the necessary facilities for stand-alone operation.

1.5.27 Nuclear Island (NI)

The NI is that portion of the plant that has within its boundary the standard reactor modules and safety-related buildings, structures, systems, portions of systems and components dedicated to assuring reactor shutdown, decay heat removal, fission product retention, and security of vital areas including storage for irradiated and unirradiated fuel. Non-safety-related buildings, structures, systems, portions of systems and components that support reactor operation, investment protection, maintenance and refueling activities may also be included at the discretion of the designer.

1.5.28 Energy Conversion Area (ECA)

The ECA is that portion of the plant not included within the NI.

1.5.29 Building Block

The MHTGR building block is a combination of one or more standard reactor modules and associated electrical generation equipment and structures that represents the smallest unit for electrical generation. Building blocks may be duplicated for capacity expansion.

1.5.30 Common Plant Facilities

Common plant facilities are those systems, structures, and components that are required to support the operation of a first building block at a new plant site and include such facilities as the administration building, provisions for refueling, general warehouse, water supply, general fire systems, etc. These common plant facilities are sized for the Reference Plant capacity.

1.5.31 Nuclear Grade

For the purposes of the MHTGR cost estimates prepared in accordance with these groundrules, nuclear grade implies practices which satisfy the requirements of 10CFR50, Appendix B.

1.5.32 Industrial Grade

For the purposes of the MHTGR cost estimates prepared in accordance with these groundrules, industrial grade means practices which satisfy generally accepted commercial requirements.

1.6 COST ACCOUNT STRUCTURES

1.6.1 Technology and Design Cost Accounts

The cost account structure used for accumulation of the Technology and Design costs is the HTGR Program Work Breakdown Structure (WBS). The WBS structure organizes work into three major categories which are described below. A listing of the MHTGR Reference Plant WBS at the four digit level of detail is given in Appendix A, Table A-1.

WBS 1000 - HTGR Technology

HTGR Technology includes Technology Transfer, Base Technology, Supporting Technology, and Technology Program Management. Technology Transfer includes the effort to provide an interface for the acquisition and transfer of applicable technical information of external programs. Base Technology includes development that is broadly applicable to HTGR concepts. Principal areas addressed within this element are fuels, graphite and materials engineering. Specific testing of systems, components or features in support of design is addressed within the context of Supporting Technology. Technology Program Management includes the internal management activities of individual participants within the HTGR Technology Program. It includes administration and technical management, planning and control, coordination with other program participants, issuance of required reports, support for Technology Program reviews, licensing support, facilities planning and quality assurance for Technology Program activities. Only costs required to support the MHTGR Reference Plant design are included in this cost estimate.

WBS 5000 - MHTGR Design

MHTGR Design comprises the effort to develop the design of the reference MHTGR and to support the development of licensing documentation. WBS 5000 is subdivided into three major divisions. Design Management (WBS 5900) provides for management of the design process within individual contractor organizations and the development of cost estimates. Plant Level Design and Analysis (WBS 5100) includes management of plant level requirements and the conduct of plant level design and analysis tasks. Systems Design (WBS 5200) provides for definition of the design at the system and component levels. A more detailed work breakdown structure under WBS 5100 and 5200 is provided in Appendix A.

WBS 9000 - Program Support

Program Support provides for support functions, including overall program coordination, the development and maintenance of long-term and annual plans at the program summary level, licensing interfaces the development and maintenance of consistent economic groundrules, and the development and management of requirements utilized as a basis for design and evaluation.

1.6.2 Capital Cost Accounts

The DOE EEDB Program code of accounts is the structure used for cost estimating and cost accumulation of the plant capital costs. The EEDB code of accounts is an evolutionary expansion and modification of the NUS-531 code of accounts. A description of the content is provided below. A listing of the EEDB accounts used for the MHTGR is given in Table B-1, Appendix B.

1.6.2.1 Direct Cost Accounts

Direct cost accounts include those construction and installation costs directly associated with the operating plant structures, systems, and components. These accounts consist of equipment costs, site labor costs and site material costs.

Equipment Costs

Equipment costs include the costs for all design, analysis, fabrication, documentation preparation, predelivery testing, and follow-up engineering performed by equipment vendors; materials for all plant equipment; transportation and insurance expenses; provision of shipping fixtures and skids; warranties; preparation of maintenance and operations manuals and handling instructions; delivery of start-up and acceptance test equipment; on-site unloading and receiving inspection expenses; and overhead expenses.

All plant equipment, whether directly associated with the power generation systems or the facility systems, such as heating and ventilation, are included in this category. For the equipment fabricated and/or assembled at an on-site fabrication facility, all the associated costs are included as equipment costs, including the costs to move the equipment within the facility and to its final on-site receiving point. All costs of factory and on-site fabricated modules are classified as equipment costs except for the site installation labor.

Site Labor Costs

The site labor portion of the construction and equipment installation costs includes all on-site activities related to permanent plant structures, systems, and equipment required for all aspects of power plant operation. The direct costs of all work crews and foremen to excavate, backfill, erect, and finish structures, and to place and install equipment, piping, wiring, etc., are included. The site labor installation hours reflect the impact of non-productive times for site entry and site exit through security, checking out special tools/equipment, and training time, as appropriate.

The costs associated with installing equipment items include the labor to transport the equipment from on-site storage to the final resting place as well as the labor to align the equipment and physically attach it to the supporting structure. In addition, the labor for providing mechanical hookups and electrical connections between interfacing systems and prefabricated modules is included.

Site Materials Cost

Site materials include all materials purchased in the field and/or bulk items such as paint, concrete, rebar, welding rod, formwork, etc. All piping less than 2-1/2 in. nominal pipe size are included as a materials item with the exception of pipe for cryogenic fluids. All wire, cable, and raceways except the control system fibre optic cabling are material items, including those in building service power systems. The control system fibre optic cabling is included with the control system equipment.

1.6.1.6 Indirect Capital Cost Accounts

The EEDB indirect cost accounts include those construction support activities required to design and build the structures and systems described in the direct cost accounts. At the two-digit account level of detail, the EEDB indirect cost accounts itemize the construction services, home office engineering and services, field office engineering and services and owner's costs.

The following subsections provide a description of the indirect costs by three-digit account numbers. This is the level of cost estimate development.

Construction Services Costs (Account 91)

Construction services include costs for activities associated with construction as indicated below:

- Temporary Construction Facilities (Account 911). This sub-account includes temporary structures and facilities, janitorial services, maintenance of temporary facilities, guards and security, roads, parking lots, laydown areas, and temporary electrical, heat, air, steam, and water systems, general cleanup, etc.

- Construction Tools and Equipment (Account 912). Construction tools and equipment include rental and/or purchase of construction equipment, small tools, and consumables (fuel, lubricants, etc.), as well as maintenance of construction equipment.

- Payroll Insurance and Taxes (Account 913). These expenses include insurance and taxes related to craft labor (direct and indirect including guards and janitors), such as social security taxes and state unemployment taxes, workmen's compensation insurance, and public liability and property damage insurance.

- Permits, Insurance, and Local Taxes (Account 914). Consistent with other EEDB estimates, builders all-risk insurance is the only cost included in Account 914. Payments to federal, state, and local governments for taxes, fees, and permits are included in Account 942, because they are plant specific.

Engineering and Home Office Services Costs (Account 92)

Engineering and home office services costs are site-specific and include all management, engineering design, licensing and associated support activities for the plant vendor entity. The costs for these services include salaries of personnel, direct payroll-related costs (DPC), overhead loading expenses, and fees for these services. This cost element consists of the following three-digit accounts:

- Reactor Module Engineering and Services (Account 920). These costs include site-specific reactor module engineering and licensing (both field and home office), procurement and expediting activities, estimating and cost control, engineering planning and scheduling, reproduction services and expenses associated with performance of the above functions.

- Plant Engineering and Services (Account 921). These costs include site-specific plant engineering and licensing (both field and home office), procurement and expediting activities, estimating and cost control, engineering planning and scheduling, reproduction services and expenses associated with performance of the above functions.

- Home Office Quality Assurance (Account 922). This account includes the services of home office quality assurance engineers and staff personnel engaged in work on the project. Services include reviews, audits, supplier surveillance, etc., as required for design and construction of the nuclear-safety-related portion of the facility.

- Home Office Project and Construction Management (Account 923). These services include those of the project manager, the construction manager and their assistants. Services of construction planning and scheduling, construction methods, labor relations, safety and security personnel are used as required.

Field Supervision and Field Office Services Costs (Account 93)

Field supervision and field office services include costs for activities associated with on-site management of construction, site QA, start-up and test, and the supporting costs. Costs of these services include salaries, DPC, overhead loading, relocation costs of key personnel, and fees. This cost element consists of the following three-digit accounts:

- Field Office Expenses (Account 931). These expenses include costs associated with purchase and/or rental of furniture and equipment, communication charges, other office supplies, etc.

- Field Job Supervision (Account 932). This management function includes the resident construction superintendent and his assistants, craft labor supervisors, field accounting, payroll and administrative personnel, field construction schedulers,

field purchasing personnel, warehousemen, survey parties, stenographers, and clerical personnel.

- Field Quality Assurance/Quality Control (Account 933). These services include those of personnel located at the job site engaged in equipment inspection, required documentation of safety-related equipment and inspection of construction activities.

- Plant Startup and Test (Account 934). These services are associated with the preparation of start-up and plant operation manuals and test procedures, direction and supervision of testing of equipment and systems as the plant nears completion and direction of start-up of the facility. Costs of any craft labor required for start-up and testing activities are included in the appropriate direct cost line items.

Owner's Cost (Account 94)

Owners' costs include the costs incurred by the owner for activities associated with the overall management and integration of the project and other costs not included in the direct capital costs incurred before the start of commercial operations as follows:

- Project Management Expenses (Account 941). This account includes cost of the owner's staff for program management and integration, engineering, licensing, and quality assurance. It also includes supporting home office services such as estimating, planning and scheduling, and purchasing, as well as payment for outside supporting services directly associated with siting, building and startup of the plant.

- Fees, Taxes and Insurance (Account 942). These expenses cover all owner's nuclear insurance premiums and local taxes, sales taxes on purchased materials and equipment incurred during the course of the project, and permits, licenses, and fees. Builder's all-risk insurance is included in Account 914.

- Spare Parts and Capital Equipment (Account 943). This account includes the initial stock of supplies, consumables and spare parts needed for testing and startup operations in addition to the plant inventories of gases (helium), fluids (water, lube oils), fuels (excluding nuclear fuel) and chemicals. Office furniture, communication equipment, transportation vehicles, laboratory equipment, house keeping gear, and other owner specific equipment are also part of this account.

- Staff Training and Startup (Account 944). The costs of the initial staffing and training of maintenance, operating, supervisory and administrative personnel are included in this account. This includes the preparation of all training materials and instruction costs, the salaries of the operating and the maintenance staff assigned to the plant prior to the plant acceptance, and their associated material and service expenses.

- G&A (Account 945). This includes general and administrative salaries plus related expenses, labor and certain regulatory expenses, outside services not applicable to other owner accounts, and public relation activities.

TABLE 1-1

MHTGR COMMERCIAL DEPLOYMENT ASSUMPTIONS

Year	Reactors Deployed	Cumulative Reactors	Plants Deployed	Cumulative Plants	Cumulative Megawatts
2007	1	1	0.25	0.25	173
2008	0	1	0.00	0.25	173
2009	0	1	0.00	0.25	173
2010	0	1	0.00	0.25	173
2011	0	1	0.00	0.25	173
2012	6	7	1.50	1.75	1,211
2013	6	13	1.50	3.25	2,249
2014	6	19	1.50	4.75	3,287
2015	6	25	1.50	6.25	4,325
2016	7	32	1.75	8.00	5,536

Table 1-2
1992 COMPOSITE LABOR CREWS AND RATES
(Effective Date: January 1, 1992)

COMPOSITE CREWS

Craft	Wage rate $/hr.	Concrete Formwork,rebar embeds,concrete		Structural Str.Steel,Misc. & Architect.		Earthwork Clearing, excav.,backfill		Mechanical Equipment Installation		Piping Installation		Instrumentation Installation		Electrical Installation	
		%	$	%	$	%	$	%	$	%	$	%	$	%	$
Boiler Maker	24.55							15	3.68						
Carpenter	24.01	40	9.60	5	1.20									2	0.48
Electrician	27.09											70	18.96	96	26.01
Iron Worker	27.48	20	5.50	75	20.61			10	2.75						
Laborer	20.94	30	6.28	5	1.05	60	12.56							1	0.21
Millwright	22.47							25	5.62						
Operating Engr.	25.49	5	1.27	15	3.82	35	8.92	12	3.06	15	3.82	2	0.51	1	0.25
Pipefitter	25.48							35	8.92	80	20.38	28	7.14		
Teamster	16.15					5	0.81	3	0.48	5	0.81				
Others	22.81	5	1.14												
		100	23.80	100	26.68	100	22.30	100	24.51	100	25.02	100	26.61	100	26.95

TABLE 1-3

COST OF MAJOR MATERIALS - BULK

(Effective Date: January 1, 1992)

Commodity Class	Commodity	Unit of Measure	Nuclear $/Unit	Non-Nuclear $/Unit
	STRUCTURAL			
1420	Formwork	SF	2.00	1.85
1421	Decking	SF	5.00	3.00
1400	Reinforcing Steel	TN	700.00	450.00
1500	Embedded Steel	LB	2.50	1.50
1430	Concrete	CY	90.00	60.00
1600	Structural Steel	TN	3,100.00	1,400.00
1610	Misc. Steel	TN	6,000.00	3,000.00
	PIPING			
6010.1	≤ 2" Screwed Pipe	LF	26.00	21.00
6010	≤ 2" CS Welded Pipe	LF	36.00	26.00
6020	≤ 2" CM Welded Pipe	LF	50.00	38.00
6030	≤ 2" SS Welded Pipe	LF	50.00	38.00
6100	4" CS sch 40(0.237") Spooled Pipe	LF	88.00	38.00
6200	4" CM sch 40(0.237") Spooled Pipe	LF	175.00	100.00
6300	4" SS sch 40(0.237") Spooled Pipe	LF	210.00	125.00
6100	12" CS sch 80(0.688") Spooled Pipe	LF	400.00	360.00
6200	12" CM sch 80(0.688") Spooled Pipe	LF	810.00	750.00
6300	12" SS sch 80(0.688") Spooled Pipe	LF	1,260.00	1,210.00
6100	20" CS sch 120 (1.5") Spooled Pipe	LF	1,100. 00	1,040.00
	ELECTRICAL			
4200	2" dia Rigid Steel Exp.Conduit	LF	7.50	5.00
4200	4" dia Non-Metal Duct Bank Conduit	LF	3.60	2.90
4280	24" x 3" Alum Cable Tray	LF	16.20	10.80
4300	600 Volt Power & Control Cable	LF	2.10	1.70
3400	600 Volt Instr. Cable	LF	1.10	0.90
4400	5-15 kV Power Cable	LF	5.50	4.40
4300	60 Volt Connections	EA	2.00	1.00
4400	5-15 kV Connections	EA	95.00	65.00

TABLE 1-4
BULK COMMODITY UNIT HOUR INSTALLATION RATES
(Effective Date: January 1, 1992)

Commodity Class	Commodity	Unit of Measure	Nuclear (Manhours/Unit)	Non-Nuclear (Manhours/Unit)
STRUCTURAL				
1420.1	Formwork- Substructure	SF	0.64	0.48
1420.2	Formwork- Other	SF	0.90	0.67
1420.3	Formwork- Superstructure	SF	1.12	0.84
1421	Decking	SF	0.16	0.12
1400.1	Reinforcing Steel-Substructure	TN	32.00	24.00
1400.2	Reinforcing Steel-Superstructure	TN	40.00	30.00
1500	Embedded Metal	LB	0.11	0.08
1430.1	Concrete-Substructure	CY	2.00	1.50
1430.2	Concrete-Superstructure	CY	4.00	3.00
1600	Structural Steel	TN	64.00	14.40
1610	Misc. Steel	TN	120.00	72.00
	PIPING			
6010.1	≤ 2" Screwed Pipe	LF	3.46	1.30
6010	≤ 2" CS Welded Pipe	LF	5.18	1.94
6020	≤ 2" CM Welded Pipe	LF	8.06	3.02
6030	≤ 2" SS Welded Pipe	LF	10.37	3.89
6100	4" CS sch 40(0.237") Spooled Pipe	LF	5.70	2.14
6200	4" CM sch 40(0.237") Spooled Pipe	LF	13.71	5.14
6300	4" SS sch 40(0.237") Spooled Pipe	LF	11.40	4.28
6100	12" CS sch 80(0.688") Spooled Pipe	LF	13.41	5.03
6200	12" CM sch 80(0.688") Spooled Pipe	LF	29.02	10.88
6300	12" SS sch 80(0.688") Spooled Pipe	LF	26.82	10.06
6100	20" CS sch 120 (1.5") Spooled Pipe	LF	42.62	15.98
	ELECTRICAL			
4200	2" dia Rigid Steel Exposed Conduit	LF	1.26	0.58
4200	4" dia Non-Metal Duct Bank Conduit	LF	0.35	0.16
4280	24" x 3" Aluminum Cable Tray	LF	2.88	1.32
4300	600 Volt Power & Control Cable	LF	0.13	0.06
3400	600 Volt Instrument Cable	LF	0.11	0.05
4400	5-15 kV Power Cable	LF	0.54	0.25
4300	600 Volt Connections	EA	0.88	0.41
4400	5-15 kV Connections	EA	20.80	9.40

Table 1-5
COMMODITY DEFINITIONS

Class	Description	Commodity Content
1420	FORMWORK	Supply, preparation, assembly, installation, removal and disposal of forming material. Commodity starting point assumes that forms are wooden and reused.
1421	DECKING	Supply, preparation, and installation of metal decking used for form concrete slabs. Decking is assumed to be galvanized steel, and remains in place after concrete is set. Area take-off is exact, and material cost includes overlap, and waste, corrugated filler, spotwelding, and other installation aids as needed.
1400	REINFORCING STEEL	Supply of straight bars or vendor-bent bars of reinforcing steel, including necessary materials for supports and field joints. Weight take-off or estimate is for rebar only. Material cost includes supports, joints and related additional material.
1500	EMBEDDED METAL	Supply, preparation, and installation of embedments, including nelson studs or other weldments as needed.
1430	CONCRETE	Supply, deliver and placement within the site of mixed structural concrete, with nominal 300 psi compressive strength. Assumed mixed in a dedicated on-site batch plant. Values include heat control or ice addition, patch and sack, curing mixes, hardeners, expansion and construction or seismic joint materials, if needed.
1600	STRUCTURAL STEEL	Supply, preparation, installation, alignment, and bolting or welding of prefabricated painted steel shapes and structures. Includes column base plates, grouting, touch-up painting, etc.
1610	MISCELLANEOUS STEEL	Supply preparation, installation, alignment, and bolting or welding of prefabricated painted steel shapes, structures, and components. This commodity includes stairs, platforms, hand railings, toe plate, door and opening frames, gratin, checker plate, etc.
6XXX	PIPING COMMODITIES	Piping commodities include pipe, fittings, hangers and supports, installation, alignment and tack-welding (when appropriate), welding, and post-weld heat treatment if necessary. Installation includes non-destructive testing, flushing, and hydrotesting. Piping excludes the material cost of valves, but includes the installation labor for valves. Separate commodities are used for insulation, vacuum jacketing, heat tracing, and painting. Piping 2 in. and smaller is predominantly supplied as straight run materials and field fabricated or on-site pre-fabricated. Larger piping is predominantly shop prefabricated and supplied to the field as spoolpieces. Only joints needed to allow shipping and installation are installed in the field.
4200	ELECTRICAL CONDUIT	Supply and installation of electrical conduit, including hinges, supports, attachments, fittings including installation devices such as pull boxes.
4280	CABLE TRAY	Supply and installation of electrical cable tray, including hangers, supports, connecting pieces, barriers, covers, etc.
3400/ 4X00	ELECTRICAL AND INSTRUMENT CABLE	Supply and installation of electrical conductors, including tray ties and other installation aids. Excludes conduit, tray, and terminations. Electrical terminations include cable end preparation and supply and installation of connectors, lugs, boots, taps, ferrules, clamps, etc.

TABLE 1-6
PLANT CAPITAL COST
FINANCIAL PARAMETERS
(For Calculating IDC)
(References 2 and 3)

	Utility	Industrial	High Leverage
Capitalization (%)			
Debt	50	30	70
Preferred Stock	10	-	-
Common Equity	40	70	30
Return on Capitalization (%/year)			
Debt	9.7	9.7	13.0
Preferred Stock	9.0	-	-
Common Equity	14.0	17.0	22.0
Average Cost of Money (%/year)	11.35	14.81	15.70
Ratio of Debt Cost/Average Cost of Money	0.427	0.196	0.580
Inflation Rate (%/year)	5.0	5.0	5.0
Real (Inflation-adjusted) average cost of money (%/year)	6.05	9.34	10.19

TABLE 1-7
FIXED CHARGE RATE
INPUT PARAMETERS
(References 2 and 3)

	Utility	Industrial	High Leverage
Effective (Tax-adjusted) Cost of Money (%/year)	9.57	13.74	12.37
Real (Tax-adjusted) Cost of Money (%/year)	4.35	8.32	7.02
Inflation Rate (%/year)	5.0		
Federal Income Tax Rate (%)	34.0		
State Income Tax Rate (%)	4.0		
Combined Tax Rate (%)	36.64		
Property Tax Rate (% of capital/year)	2.0		
Interim Replacement Rate (% of capital/year)	0.5		
Book/Analysis Life (year)	30		
Tax Depreciation Period (year)	15		
Tax Depreciation Method	150% Declining Balance		
Accounting Method	Normalized		

TABLE 1-8
NUCLEAR FUEL CYCLE ASSUMPTIONS
(References 2 and 3)

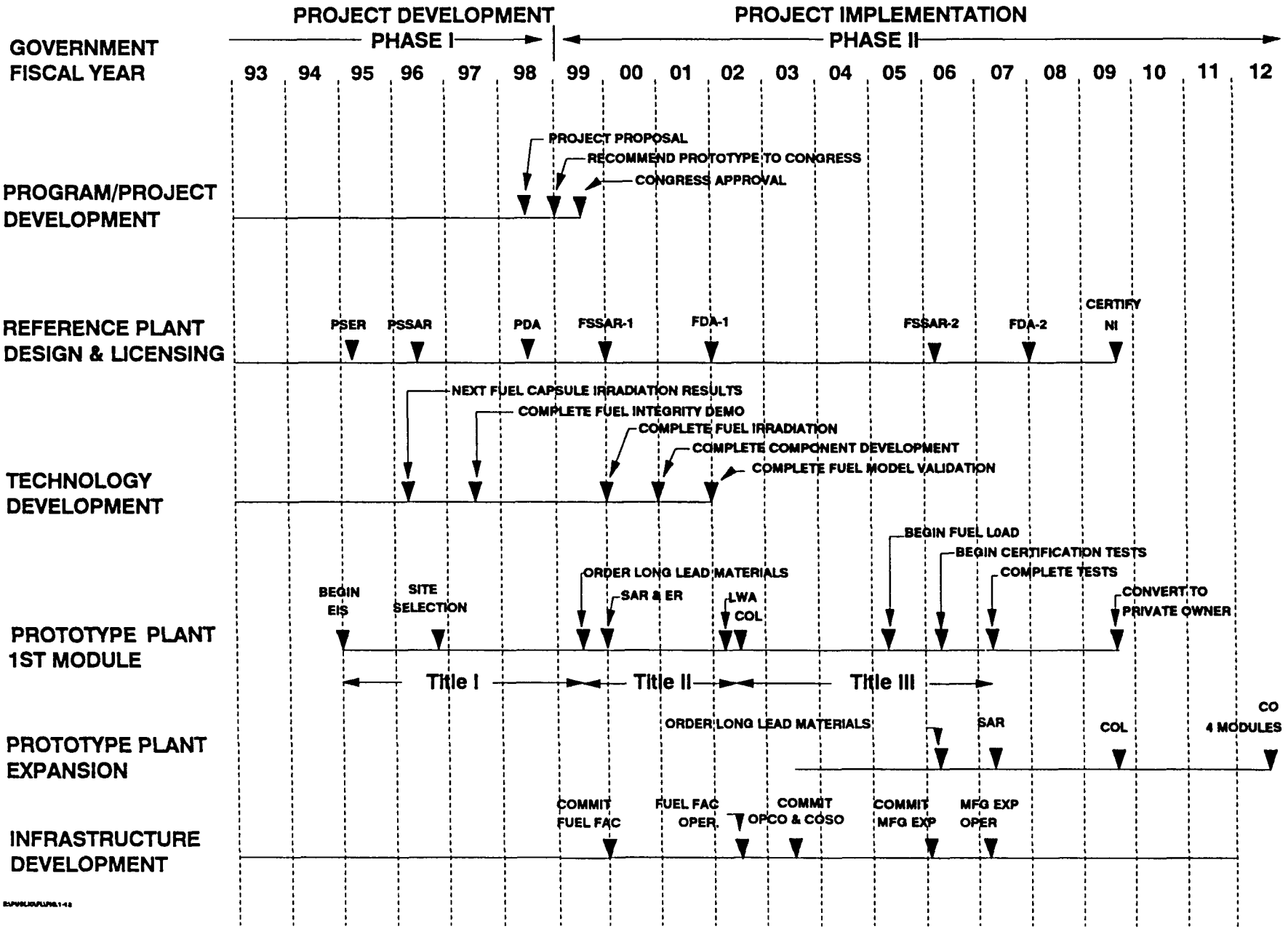
Component	Price (1992$)	Real Escalation (%/Year)
U_3O_8, $/lb	25	0.0
Conversion, $/kg U	10	0.0
Enrichment, $/kg SWU, $\leq$ 10.5%	125	0.0
Enrichment, $/kg SWU $\geq$ 10.5%	925	0.0
Waste Disposal, mills/kWhr	1.0	0.0

TABLE 1-9
FOSSIL FUEL COST ASSUMPTIONS
(References 2 and 3)

Fossil Fuel	Price (1992$)	Real Escalation (%/Year)
Coal	$1.45	1.0
Natural Gas	$2.33	2.2

FIGURE 1-1
MHTGR PROGRAM/PROJECT SCHEDULE

11/12/93



SECTION 2

TECHNOLOGY AND DESIGN DEVELOPMENT COSTS

This Section presents the technology and design development costs required to achieve FDA-1 (See Figure 1-1). All costs presented in this section are intended to be 50% confidence cost estimates, that is, an equal probability that the actual costs incurred will be higher or lower. In addition, a 90% confidence level judgement factor is included for the technology and design development cost estimates to indicate the relative degree of uncertainty. The total front-end costs required to reach the commercial deployment stage, including the capital costs and initial operating costs associated with the Lead Module, plus Prototype Plant expansion and infrastructure development, are presented in Section 6.

The estimated development costs reflect program status as of September 30, 1992 and, as such, include estimates for work planned and completed in government fiscal year 1993. The technology and design development program and scope continues to evolve as work is completed and new design data needs are identified. During 1993, MHTGR technology plans were updated which included a significant update of the Fuel/Fission Product Development that may increase development costs over that reported herein. During FY 1994, updated technology plans will be issued and cost estimates will be updated accordingly.

2.1 TECHNOLOGY COSTS

The MHTGR is fundamentally different than other nuclear power generation alternatives in the use of graphite fuel blocks, non-metallic fuel encapsulation, helium coolant, and higher reactor operating temperatures. These features offer substantial improvements in performance and safety over commercially available nuclear technologies. However, providing the data required by the designers, regulators and code committees to confirm the technical superiority of the MHTGR requires a technology development program. The MHTGR technology development costs are presented in Table 2-1 by major category for the MHTGR-SC, MHTGR-GT/IC, and MHTGR-GT/DC concepts. This summary table was developed from more detailed input provided by the technically responsible organizations at the 4 digit WBS Level. In accordance with Figure 1-1, technology development activities are scheduled to be completed by the end of 2001, consistent with the schedule for final design approval (FDA-1) from the NRC.

The scope of work involved in the MHTGR-SC technology development activities is defined in the Description of Work Statements (Reference 12). The $298 million technology development cost is dominated by the fuel, fission product behavior and fuel process development activities which comprise $158 million or more than 53% of the total technology program. An additional $48 million or 16% is associated with graphite and high temperature metals development. Design verification and support (DV&S) for the MHTGR-SC comprises $71 million or 24% of the technology program costs. Program management, $9 million, and miscellaneous categories add the remaining $12 million in MHTGR-SC technology development costs. The weighted 90% confidence factor for the

MHTGR-SC is 136%, leading to a MHTGR-SC 90% confidence technology cost estimate of $405 million.

The MHTGR-GT concept estimates were developed based on specific differences in technology requirements. However, most of the MHTGR-SC technology program as it relates to fuel, fission product behavior, fuel process, graphite, metals, reactor cavity cooling system, and fuel handling are the same for all MHTGR concepts. The MHTGR-GT/IC technology development cost estimate is nearly 8% higher than the MHTGR-SC at $321 million. Table 2-1 identifies increases in the circulator ($11 million), turbomachine ($5 million), and international technology transfer ($6 million) development costs to deploy the MHTGR-GT/IC concept. A much larger circulator, a high temperature helium to helium intermediate heat exchanger replacing the steam generator, and the closed cycle helium turbomachine are the reasons for the MHTGR-GT/IC technology program cost increases. The uncertainty in the MHTGR-GT/IC estimate increases slightly to 139%, leading to a MHTGR-GT/IC 90% confidence technology cost estimate of $446 million.

The MHTGR-GT/DC represents further advancement in technology from the MHTGR-SC. While the reactor system is basically unchanged, significant changes in the power conversion system are included in the MHTGR-GT/DC. Elimination of the main circulator and steam generator and the introduction of an intercooled, recuperated closed cycle helium turbine in the primary loop result in additional increases in technology program costs. The recuperator, intercooler, and precooler arranged with a vertical *turbomachine running on magnetic bearings with a helium cooled submerged generator* represents a significant departure from current commercial technology. As a result, a full scale test of the power conversion system has been recommended and the costs are included in the turbomachine line item. For the purposes of the technology development cost estimate, it is assumed that the power conversion loop components would be tested in a fossil fired test facility and subsequently removed and deployed in the MHTGR-GT/DC Lead Module. Thus, the capital cost of the power conversion equipment, including the turbomachine, heat exchangers and generator is not included in the development costs presented. The MHTGR-GT/DC turbomachine test facility capital cost is estimated to be $70 million. Startup and two years of operation for testing are estimated to cost $35 million. An additional $10 million was included for the power conversion test vessel. The $91 million increase in technology program costs relative to the MHTGR-GT/IC is dominated by the $115 million cost for the turbomachine test facility. This is offset by elimination of the circulator DV&S (-$34 million). Additional costs are also estimated for the metals technology, $5 million, and reactor system DV&S, $11 million, due to complexities related to placing the turbomachine in the primary system. The MHTGR-GT/DC technology development cost is estimated to be $422 million, which 42% higher the MHTGR-SC and 31% higher than the MHTGR-GT/IC.

2.2 DESIGN COSTS

The MHTGR design and licensing development costs are based on the development of a standardized plant design, preparation and submittal of the Preliminary and Final Standard Safety Analysis Reports (PSSAR and FSSAR) to the Nuclear Regulatory Commission (NRC), and interactions with the NRC to obtain Preliminary Design Approval (PDA) and Final Design Approval (FDA). Additional design efforts required to manufacture

components and construct the Lead Module are included in the Lead Module capital cost estimate. Engineering and licensing activities beyond the FDA-1 (See Figure 1-1) to obtain the MHTGR standard plant design certification are also not included in Table 2-1, but are discussed in Section 6.

Design development costs are estimated at $436, $514, and $549 million for the MHTGR-SC, MHTGR-GT/IC, and MHTGR-GT/DC, respectively. Turbomachinery design costs account for a large fraction of the design development cost increase relative to the MHTGR-SC, with the MHTGR-GT/IC turbomachine design costs estimated at $41 million and the MHTGR-GT/DC estimated at $90 million. Plant level design and analysis activities, reactor design, and licensing activities are also envisioned to be higher for the MHTGR-GT concepts.

Summary cash flows for the technology and design development costs for the three MHTGR concepts are presented in Table 2-2. Due to rounding, small differences in the total technology and design development costs reported on Tables 2-1 and 2-2 are noted. Table 2-2 is a more accurate presentation of the development cost input prepared by the MHTGR Program participants. For the present, each concept was assumed to be developed to support the schedule given in Figure 1-1, which is responsive to the Energy Policy Act of 1992.

DOE Program management costs and NRC staff costs to review the MHTGR design are not included in the above design development cost estimates. These costs are excluded from the above design development effort in accordance with the Advanced Reactor Cost Estimating Guidelines (Reference 3). As the NRC staff costs and DOE staff costs are thought to be required and comparable for any advanced reactor technology, these costs may be excluded for comparison purposes. However, it is recognized these costs must be incurred. NRC staff review costs for the Preliminary Safety Evaluation Report, the Preliminary Standard Safety Analysis Report, and the Final Standard Safety Analysis Report are addressed in Section 2.3 below. NRC staff review costs associated with design certification are addressed in Section 6.1.

2.3 NRC STANDARD DESIGN REVIEW

A scoping estimate was prepared for the NRC staff costs associated with reviewing the MHTGR design and issuing the Preliminary Safety Evaluation Report (PSER), PDA, and FDA-1 in accordance with the schedule shown in Figure 1-1. A total of 65 NRC staff-years were included in the estimate and are assumed to be billed at cost. The fees charged for NRC services for licensing of facilities are covered in Part 170, Title 10 of the Code of Federal Regulations (CFR). In 1992, the average cost per NRC Professional staff-hour was $123 per hour. Allowing for 200 hours of vacation, holiday, and sick hours per year and 1,880 hours chargeable to applicants per year, the NRC staff cost per year would be $231,240. The total cost estimated for NRC staff review through FDA-1 in 2001 would be approximately $15 million based on the scoping estimate of 65 staff-years. Table 2-3 provides the assumed staffing and cash flow requirements by fiscal year.

NRC staff costs specific to each MHTGR plant are included in the capital cost estimates presented in Sections 3, 4, and 5 under owner's costs and documented in Reference 12. NRC staff review efforts to support FDA-2 and design certification are addressed in Section 6.

TABLE 2–1
MHTGR DEVELOPMENT COST SUMMARY
(1992 M$)

COST CATEGORIES	Steam Cycle		Gas Turbine – IC		Gas Turbine – DC	
	50%/50% Estimate	90% Conf. Factor	50%/50% Estimate	90% Conf. Factor	50%/50% Estimate	90% Conf. Factor
TECHNOLOGY DEVELOPMENT						
FUELS DEVELOPMENT; FP BEHAVIOR	100	145%	100	145%	100	145%
GRAPHITE DEVELOPMENT	22	109%	22	109%	22	109%
METALS DEVELOPMENT	26	110%	26	111%	31	110%
FUEL PROCESS DEVELOPMENT	58	150%	58	150%	58	150%
REACTOR SYSTEM DV&S	19	150%	19	150%	30	150%
CIRCULATOR DV&S	23	130%	34	130%	0	N/A
HEAT EXCHANGER DV&S	8	130%	6	150%	5	150%
TURBOMACHINERY DV&S	0	N/A	5	150%	125	170%
SHUTDOWN COOLING SYS. DV&S	7	130%	9	130%	9	130%
REACTOR CAVITY COOLING SYS. DV&S	5	141%	5	141%	5	141%
FUEL HANDLING & STORAGE SYS. DV&S	5	175%	5	175%	5	175%
PLANT CONTROL/PROTECTION SYS. DV&S	4	140%	4	140%	4	140%
PROGRAM MANAGEMENT	9	134%	10	121%	10	129%
MISC. (SAFETY, INT'L TECH TRANSFER)	12	161%	18	146%	18	146%
SUBTOTAL TECH. DEVELOPMENT	298	136%	321	139%	422	149%
DESIGN AND LICENSING						
PLANT LEVEL DESIGN & ANALYSIS	75	144%	84	147%	88	149%
REACTOR SYSTEM	80	145%	94	150%	94	150%
VESSEL SYSTEM	19	130%	19	150%	21	150%
CIRCULATOR	12	140%	18	140%	0	140%
HEAT EXCHANGERS	25	130%	25	150%	25	150%
TURBOMACHINERY	0	N/A	41	150%	90	150%
SHUTDOWN COOLING SYSTEM	15	137%	15	143%	15	143%
REACTOR CAVITY COOLING SYSTEM	3	140%	3	140%	3	140%
FUEL HANDLING & STORAGE SYSTEM	17	174%	17	174%	17	175%
OTHER NI SYSTEMS	15	127%	16	129%	14	134%
PLANT INSTRUM., CONTROL & PROTECT.	21	129%	18	133%	17	134%
TURBINE PLANT EQUIPMENT	7	106%	5	97%	1	60%
NI BUILDINGS & STRUCTURES	20	126%	20	129%	20	126%
ECA BUILDINGS & STRUCTURES	4	100%	3	121%	1	157%
PLANT AIR, WATER & SERVICE SYS.	11	109%	9	118%	8	122%
PLANT ELECTRICAL & SECURITY SYS.	11	121%	10	121%	9	124%
DESIGN MGT. & COST DEVELOPMENT	56	130%	66	138%	65	143%
REQ'TS, PLANNING & CONTROL, QA	25	125%	30	137%	28	147%
LICENSING MANAGEMENT	20	157%	21	157%	33	157%
SUBTOTAL DESIGN & LICENSING	436	137%	514	144%	549	147%
TOTAL DEVELOPMENT COST	734	136%	835	142%	971	148%
FACTOR RELATIVE TO SC	1.00	100%	1.14	104%	1.32	108%

TABLE 2–2
MHTGR TECHNOLOGY AND DESIGN DEVELOPMENT CASH FLOW SUMMARY
(1992 M$)

	FY93	FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	TOTAL
MHTGR–SC												
TECHNOLOGY	18.0	20.5	40.3	57.7	59.4	46.2	32.6	17.7	5.3	0.0	0.0	297.7
DESIGN	14.3	43.4	61.0	67.7	72.4	60.7	50.7	41.9	20.6	2.0	0.0	434.7
TOTAL MHTGR–SC	32.3	63.9	101.3	125.4	131.8	106.9	83.3	59.6	25.9	2.0	0.0	732.4
MHTGR–GT/IC												
TECHNOLOGY	17.2	20.8	41.7	64.1	65.5	50.8	36.0	19.8	5.3	0.0	0.0	321.2
DESIGN	14.4	46.8	70.7	79.1	85.7	73.6	57.9	50.3	27.1	9.2	0.0	514.8
TOTAL MHTGR–GT/IC	31.6	67.6	112.4	143.2	151.2	124.4	93.9	70.1	32.4	9.2	0.0	836.0
MHTGR–GT/DC												
TECHNOLOGY	17.2	21.0	47.0	59.9	60.6	64.0	67.1	49.3	25.4	10.0	0.0	421.5
DESIGN	14.2	46.8	81.4	90.4	102.6	87.7	61.2	41.0	18.2	6.2	0.0	549.7
TOTAL MHTGR–GT/DC	31.4	67.8	128.4	150.3	163.2	151.7	128.3	90.3	43.6	16.2	0.0	971.2

TABLE 2–3
ALLOWANCE FOR NRC STAFF REVIEW OF STANDARD MHTGR DESIGN
(1992 M$)

	FY93	FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	TOTAL
NRC STAFF–YEARS	2	3	4	6	10	10	10	10	10	0	0	65
7	0.5	0.7	0.9	1.4	2.3	2.3	2.3	2.3	2.3	0	0	15.0

SECTION 3

MHTGR-SC CAPITAL COST ESTIMATE RESULTS

3.1 PLANT BASE CONSTRUCTION COSTS

The base construction costs for the MHTGR-SC Prototype Plant Lead Module with common facilities and the completed Prototype, Replica and Target (NOAK) Plants are summarized to the two-digit EEDB cost account level in Tables 3-1(a), 3-1(b), 3-1(c) and 3-1(d), respectively. A breakdown of the equipment, labor and material component costs and labor manhours is provided and further subdivided by Nuclear Island (NI) and Energy Conversion Area (ECA). Similar cost tables detailed at the three-digit cost account level are given for each of the plants in Appendix C, Tables C-1, C-2, C-3, and C-4, respectively. By convention, and to provide separation of costs, the reactor manufacturer's home office engineering indirect cost (Account 92) is itemized in the NI factory equipment cost column. Other indirect costs in Accounts 91, 92, and 93 pertaining to Construction Services, Home Office Engineering and Field Office Services are split between the NI and ECA and allocated to site material and site labor as appropriate. The Owner's Cost (Account 94) is separated into labor and material classifications in the ECA cost column.

The capital costs presented in Tables 3-1(a) through (d) and C-1 through C-4 represent "most likely" cost estimates including an allowance for indeterminates but exclude contingency. Actual equipment costs were based on vendor quotes on commercially available items, in some cases adjusted for quantity purchases supported by the deployment scenario, or vendor pricing of MHTGR specific components and the application of a learning curve. Overall, NI factory equipment costs represent over 27% of the base construction cost for the Lead Module and ECA equipment costs represent an additional 10%. The Prototype Plant equipment costs rise as a percentage of total base construction costs to 33% for the NI and 12% for the ECA, primarily due to the common facilities. The MHTGR-SC Target Plant factory equipment percentages change slightly to over 34% for NI factory equipment and over 14% for the ECA factory equipment primarily due to the application of learning on NI equipment specific to the MHTGR.

Direct site material represents approximately 10% of total direct costs for the MHTGR-SC Prototype Plant. As no learning is applied to the bulk materials, the direct site material cost is identical for the four module Prototype, Replica, and Target Plants while total direct costs decline due to the application of learning. Direct site labor costs as a percentage of total direct costs varies from 21% for the Lead Module to over 18% for the Prototype Plant. The MHTGR-SC Target Plant direct site labor is 18.8% of total direct cost and 12.8% of total base construction costs.

Total direct costs as a percentage of base construction costs varies from over 56% on the Lead Module to over 70% on the MHTGR-SC Target Plant. This increase in the direct cost contribution is due to elimination of design efforts required for the Lead Module and the assumption that standardization and certification of the design is successful and multiple MHTGR orders are placed by the vendor team to supplier organizations. As a result, substantial reductions are obtained in home office engineering.

3.1.1 Site Labor Costs

The data in Table 3-3 indicate that direct site labor costs account for between 12 and 13% of the total base construction costs. The percentage rises from the Prototype Plant to the Target Plant because equipment and indirect FOAK costs and equipment learning reduces plant costs at a faster rate than the learning applied to field labor. Overall direct site labor is a minor contributor to overall base construction costs. However, the indirect labor cost algorithm used by BNI to estimate NI indirects is also directly related to site labor cost.

Tables 3-4(a), 3-4(b), 3-4(c), and 3-4(d) provide a summary of crew manhours by 2 digit EEDB account for the NI and ECA for the four plant scenarios examined. The MHTGR-SC Lead Module site labor manhours are estimated to be nearly 3.4 million, of which 2.1 million are associated with NI construction. For the four module Target Plant the total site labor manhours increase to nearly 6.5 million, of which 4.1 million are related to NI construction. The MHTGR construction activities are heavily weighted towards structures and improvements relative to other nuclear concepts. Over 36% of the manhours are associated with NI structures and improvements. An additional 8 to 10% of total manhours are involved in ECA structures and improvements. Whereas typical nuclear power plants have much more piping, equipment, and electrical installation manhours, the MHTGR is dominated by construction of structures and improvements. Historically, there has been less schedule and cost risk associated with installation of concrete and steel for buildings relative to the installation of piping, equipment, and electrical items inside the completed structures.

For the MHTGR-SC Target Plant, nearly 21% of the total manhours involve the electrical crew, nearly 18% the mechanical crew, 15% the piping crew, and 3% for the instrument crew. The instrument crew is newly defined in the 1993 cost estimate update and the manhours reported here would have been reported in prior estimates as electrical crew. Related to structures and improvements, over 29% of the total manhours involved the concrete crew, 9% for the structural crew, and nearly 5% for the engineering crew.

The MHTGR-SC design has not taken full advantage of modularization potential in the design estimated in this report. Structures and improvements dominate the NI cost and limited applications of modularization have been incorporated in the NI design, primarily skid mounted equipment modules. No effort has been undertaken to investigate or incorporate modular design features into the ECA as of this date even though the potential cost savings and manpower reductions were noted in 1990 in the MHTGR Cost Reduction Report (Reference 5). With the evolution of standardized, modular fossil and nuclear plant ECA designs, the MHTGR-SC is recognized to have further cost reduction potential and may take advantage of advances in these areas. The expected cost reductions would be embodied in further reductions in site labor manhours, offset somewhat by increases in factory equipment costs and corresponding reductions in plant indirect costs to the extent these costs are directly related to field labor costs.

Tables 3-5(a), 3-5(b), 3-5(c), and 3-5(d) presents the breakdown of site craft labor manhours in a similar format to Tables 3-4(a)-(d) based on the crew mix specified in Table 1-2. All of the cost accounts show reductions in the labor man-hours due to learning in going from the Prototype Plant to the Target Plant.

Reductions in construction services and field office services are also accomplished, in part due to the reduced field labor hours calculated due to learning. The reactor vendor Home Office Engineering estimates were provided by GA. The remainder of the NI indirects were based on an algorithm developed by BNI and is related primarily to field labor hours, although plant schedule and equipment/material procurement also impact the NI indirects. For the ECA, SWEC estimated the indirect costs in Accounts 91, 92 and 93, based on their scope in the ECA, and GCRA developed the owner's costs as documented in Reference 13.

A comparison of the base construction costs and percentage of total plant cost by 3 digit EEDB account for the Prototype, Replica, and Target Plants is given in Table 3-2. Table 3-2 also illustrates the plant to plant account cost reductions due to elimination of FOAK costs and application of learning. A summary of nuclear island, energy conversion area, and total base construction costs by direct and indirect cost categories is given in Table 3-3. Tables 3-2 and 3-3 show that in evolving from the Prototype to the Target Plant, the NI base construction costs decline by 24%, the ECA base construction costs decline by about 8% and the total plant costs decline by nearly 21%.

Table 3-2 also shows that the major reductions in the NI costs occur in Account 22, Reactor Plant Equipment, and in the indirect costs with the largest indirect cost reduction being in Account 92, Home Office Engineering. The reduction in the reactor plant equipment account is attributable to FOAK equipment costs and equipment cost reductions due to learning. The reduction in the indirect costs is attributed to FOAK design costs, standardization and learning.

Table 3-3 also shows that, in evolving from the Prototype to the Target Plant, the ECA direct costs are reduced 4.6%. This cost reduction is attributed to turbine generator equipment cost reductions relative to the Lead Module due to quantity purchases, the improvement in site labor productivity assumed due to the National Labor Alliance and implementation of rolling 4 x 10 schedules for the Target Plant, and to site labor learning. The contribution of site learning is minimal as the ECA contains standard commercial equipment and is constructed in accordance with standard commercial practice. More sizeable reductions occur in the indirect costs. The Home Office Engineering account declines by nearly 80% resulting in a 20% reduction in ECA indirect costs, and is attributable to design standardization and replication.

In summary, the 20.7% cost reduction achieved in moving from the Prototype to the Target Plant is comprised of:

- 2.2% due to equipment FOAKs
- 4.3% due to reactor equipment learning
- 0.3% due to other equipment learning
- 1.1% due to construction learning and improvements in productivity
- 3.1% due to owner's cost reduction primarily due to reduced staffing requirements
- 4.0% due to design and licensing indirect account FOAKs
- 5.7% due to learning and design standardization in the indirect accounts

Tables 3-6(a), 3-6(b), 3-6(c), and 3-6(d) provide a different look at the site craft labor breakdown for the MHTGR-SC Lead Module, Prototype, Replica and Target Plants, respectively. The labor man-hours are summarized by craft at the two-digit account level for each of the plants in for the following crafts: boilermakers, carpenters, electricians, ironworkers, laborers, millwrights, operating engineers, pipefitters, teamsters, and other craft labor. The data in these tables indicate the most highly utilized craft to be pipefitters accounting for over 25% of the total direct labor hours on the Prototype, Replica and Target Plants. For the Target Plant, the next most utilized crafts are electricians at 17.8%, iron workers at 14.3%, carpenters at 12.2%, laborers at 12.2% and operating engineers at 9.4%. All of the other crafts combined account for the remaining 9% of craft labor hours on the MHTGR-SC Target Plant.

Application of the same labor rates used in the USCEA Study (Reference 9) nuclear cost estimates would result in a $11.8 million reduction in MHTGR-SC Prototype Plant direct labor costs. The MHTGR-SC Target Plant direct labor costs would be reduced by $10.6 million.

3.1.2 Factory Equipment and Site Material Costs

Summaries of the factory equipment and site material direct costs by EEDB account for the MHTGR-SC Prototype, Replica and Target (NOAK) Plants are provided in Table 3-3. The factory equipment direct costs account for about 45-48% of the total base construction costs. The site material costs account for about 6-8% of the total base construction costs.

Table 3-3 also shows that nuclear island factory equipment costs amount to over 33% of total base construction costs, nearly 95% of which is contained in Account 22, Reactor Plant Equipment. The second most significant factory equipment account is the Turbine Plant Equipment, Account 23, which contains over 21% of the total factory equipment costs and nearly 10% of total base construction costs.

The only factory equipment accounts which contain any reductions in costs in evolving from the Lead to the Target Plant are Reactor Plant Equipment, Account 22 and the Turbine Plant Equipment, Account 23. Table 3-7 details the major reactor plant equipment items included in the reactor manufacturer scope. Table 3-7 itemizes the learning factor applied, factory FOAK costs, and equipment cost details for the Lead Module, Prototype, Replica, and Target Plants. Learning is applied at the 94% factory equipment guideline for all reactor equipment except the reactor and steam generator vessels, steam generators, shutdown cooling heat exchangers, and the major equipment transportation costs. No learning is applied to the equipment transportation costs. Although previous studies justified lower learning factors (95% for vessels and 91% for heat exchangers), a higher effective learning factor was selected to recover all facility costs over a 12 year period, production of 44 units. A 98% learning factor is applied to the vessels and a 96% learning factor for the heat exchangers. This 12 year recovery period is projected to be conservative relative to other reactor plant equipment and yields substantially higher Target Plant equipment costs relative to the 94% default learning factor guideline. Changing the vessel learning factor from 96% to 98% increased Target Plant direct costs by $9 million. The direct cost impact of changing the heat exchanger

learning factor from 94% to 96% was a $5.7 million increase in Target Plant costs. The more conservative learning factors applied to the vessels and heat exchangers result in a $17.5 million increase in MHTGR-SC Target Plant overnight costs (a 1.7% increase). The Reactor Plant Equipment account also contains equipment FOAK costs of $26.3 million, excluding contingency.

FOAK design, tooling and setup costs of $6.7 million have been included in the MHTGR-SC Lead Module steam turbine costs. While no learning curve has been applied to the steam turbine, quantity purchase assumptions compatible with the deployment schedule identified in Section 1 have been applied to subsequent commercial steam turbine generator sales. The commercial steam turbine costs for the Prototype, Replica, and Target Plants were 28% less than that for the MHTGR-SC Lead Module including FOAKs. No reductions in cost occur in the other factory equipment accounts as the equipment is assumed to be commercially available.

Table 3-3 also shows that NI site materials cost comprise 4-5% of total base construction costs and the ECA site materials comprise 2-3% of total base construction costs. Nearly 50% of the direct site material costs are associated with NI structures and improvements and another 13% associated with ECA structures and improvements. No learning factors are applied to site materials.

To permit comparison on a bulk basis of selected site materials (i.e., commodities) with alternative plants, bulk commodity data are given in Table 3-8 for the MHTGR-SC Lead Module and in Table 3-9 for the MHTGR-SC Target Plant. The Prototype and Replica Plants have the same quantities as the Target Plant. The data in Tables 3-8 and 3-9 is provided by 2-digit EEDB Account for the NI, ECA and total plant. The structural materials identified in Tables 3-8 and 3-9 are assumed to be non-nuclear for the purposes of costing consistent with the ACI 318 construction code approach. As the NI structures are only required to maintain their structural integrity and are not designed to maintain a pressure boundary, the lower non-nuclear costs are appropriate. Other materials in the NI are nuclear grade, and carry the higher nuclear commodity prices and installation manhour rates.

3.1.3 Indirect Costs

The indirect cost estimates were developed by BNI, GA, GCRA, and SWEC. GA estimated the reactor module engineering & services, Account 920, covering indirect costs associated with supply of the reactor plant equipment including the ABB/CENP scope of supply. BNI developed the indirect costs for the NI design and construction and SWEC provided the estimate for the ECA. GCRA prepared the owner's cost estimate, Account 94.

FOAK indirect costs to support the Lead Module design and construction were estimated to be $6 million for the reactor manufacturer's scope, $40 million for the NI design and construction scope, and $15 million for the ECA design and construction scope. These FOAK costs are costs incurred over and above the standard design and licensing costs and cover completion of system and structural designs beyond that required for licensing and the FDA, preparation of procurement specifications,

construction and fabrication drawings, construction procedures and sequencing, startup procedures, and other details required for construction. Construction of following reactor modules would use this information directly due to the standardized, replicated design.

Recurring MHTGR RM indirects were estimated by GA to be nearly $16 million per module with a 76% learning curve. The RM indirects for the Prototype Plant were estimated to be nearly $47 million. Due to replication of the standardized, certified design and the streamlined Target Plant construction schedule, the Target Plant RM indirects were estimated to fall to $17 million. Recurring RM indirects were estimated to be 10.8% of total RM equipment direct costs for the Prototype Plant, 7.5% for the Replica Plant, and 4.7% for the Target Plant. These reductions in cost are realizable only if the groundrule assumptions hold, that is, no changes in regulations or design and no funding restrictions during construction.

Recurring architect engineering NI indirects were estimated by BNI and included support to obtain site specific permits and licenses. The NI indirects were estimated using an algorithm based on Bechtel experience with other nuclear projects, all monolithic LWR's. This algorithm is based primarily on field labor cost, although the plant thermal output, length of construction schedule, and value of procured equipment and materials are also accounted for. Concerns were raised regarding the applicability of LWR experience with non-standard designs during times of rapidly changing regulations and designs, rapid inflation, and cash flow restrictions. As such, it is difficult to apply a historically based algorithm to the groundrule conditions even if based on some of the better nuclear experience. BNI has acknowledged that the repetition of a certified design, and groundrules prohibiting design changes, are inconsistent with the algorithm methodology, which was based on "good" experience with single-copy designs.

Bechtel's historically based algorithm is presented in the formulas below:

Account 91: Construction Services (in 1992 Dollars)

$$4{,}320{,}000*(P/1{,}200)^{.333} + .62*LN + 268{,}000*M*(P/1{,}200)^{.5} + 150{,}000*M$$

Account 93: Field Supervision and Field Office Services (in 1992 dollars)

$$.36*LN + 85{,}900*M*(P/1{,}200)^{.5} + .025*TN$$

Account 92: Home Office Engineering and Services

$$17{,}220{,}000 + .16*(E+MN) + .11*(LN+91+93)$$

Where,

P	=	Power Level (MWe)
LN	=	NI Direct Field Labor ($)
M	=	Site Construction Schedule Duration (Months)
TN	=	NI Procured Modules ($)
E	=	NI Equipment ($)
MN	=	NI Field Material ($)
91	=	NI Construction Services Cost ($)
93	=	NI Field Supervision and Field Office Cost ($)

Subaccount allocations were provided that allocated 70% of the total 91 account costs to labor and 84% of the total 93 account costs to labor. Overall, the terms related to NI field labor cost (LN) contribute 65% of total NI indirect costs. The algorithm is driven heavily by field labor content, with each dollar of field labor cost resulting in $1.17 of indirect cost.

Some adjustments were made to the standard BNI algorithm to generate the MHTGR Replica and Target Plant capital costs to make the algorithm generated indirect costs more consistent with a standardized, replicated design. These adjustments include:

(1) A reduction in the home office engineering factor, Account 92, from 11% to 6% of total field manual and non-manual labor for the Replica and Target Plants due to elimination of bid specifications, competitive bids, and incorporation of new equipment interfaces in each plant design. The MHTGR deployment scenario provides for preselection of the vendor/supplier team with contractual commitments to supply future orders allowing for truly standardized and replicated MHTGR plants. For the same reason, the equipment term (E) in the home office engineering account was also eliminated, reflecting a reduced procurement support.

(2) A reduction in the field labor supervision and QA factor (Account 36) from 36% to 33% to account for the construction and field labor emphasis on structures rather than piping and electrical systems. The MHTGR design, by it's very nature, has eliminated many mechanical and electrical systems required in LWR plant construction. The amount of field supervision and the schedule risk associated with concrete and steel construction is less than that required for mechanical and electrical systems.

These changes to Bechtel's historically based algorithm for the Replica through Target Plants are presented in the formulas below:

Account 91: Construction Services (in 1992 Dollars)

$$4{,}320{,}000*(P/1{,}200)^{.333} + .62*LN + 268{,}000*M*(P/1{,}200)^{.5} + 150{,}000*M$$

Account 93: Field Supervision and Field Office Services (in 1992 dollars)

$$.33*LN + 85{,}900*M*(P/1{,}200)^{.5} + .025*TN$$

Account 92: Home Office Engineering and Services

$$17{,}220{,}000 + .16*(MN) + .06*(LN+91L+93L)$$

Where,

91L = NI Construction Services Labor Cost ($)
93L = NI Field Supervision and Field Office Labor Cost ($)

The total recurring NI indirects were estimated by the algorithm to be $132 million for the Lead Module, or 40% of total NI direct costs and 28% of total direct costs. Application

of field learning and the shortened construction schedule led to reductions in recurring NI indirects in following commercial plants. The estimated recurring NI indirects were $212, $158, and $154 million for the Prototype, Replica, and Target Plants, respectively. NI indirect costs range from 31% of total NI directs and 22% of total plant directs for the Prototype Plant to 27% and 18%, respectively for the Target Plant.

Recurring architect engineering ECA indirects were estimated by SWEC based on their non-nuclear experience and did not include any support for site specific permitting and licenses which was included in the NI indirects. The recurring ECA indirects were estimated to be $28 million for the Lead Module and $62 million for the Prototype, Replica, and Target Plants. These costs represent approximately 22% of the ECA direct cost and 7% of total plant direct costs.

The Reference 3 DOE cost estimating guidelines encourage a detailed, task related estimate. Because of the aforementioned difficulties in relating historical experience with the groundrule scenario and providing supportable, technology related adjustments, a high priority should be placed on developing the scope of work contained in all the indirects and their corresponding costs in the next overall cost estimate update effort. This effort should address both FOAK and recurring costs under the guidelines, especially as these costs may be related to historical experience on one-of-a-kind LWR plant designs.

The Owner's costs (Account 94) in the MHTGR base construction cost estimates were developed on a bottom-up basis, Reference 13, and a summary of the results is given in Table 3-10. These results indicate that the owner's cost could range from about 13% of the other direct and indirect costs for the Prototype Plant to about 12% of the other direct and indirect costs for the Target Plant.

3.1.4 Summary of MHTGR-SC Base Construction Costs

Table 3-11 provides a breakdown of MHTGR-SC Target Plant base construction costs at the three digit level by cost estimating organization. Additional detail is provided for the reactor complex buildings, Account 212. The percentage contribution of each cost account to the total base construction costs is also noted together with the percentage by estimator. For the MHTGR-SC, 70% of the total base construction cost is direct cost and 30% is estimated to be indirect costs. Reactor Plant Equipment, Account 22 represents 34.7% of the total base construction costs. Turbine Plant Equipment, Account 23 at 12.8%, and Structures and Improvements, Account 21 at 12.3%, are the next largest contributors to MHTGR-SC Target Plant capital cost. Land and owner's costs are estimated to be 11.0% OF MHTGR-SC base construction cost.

MHTGR-SC Target Plant base construction costs are estimated to be $1,218 million. Tables 3-1, 3-2, and 3-3 identify total base construction costs for the four MHTGR-SC plant scenarios estimated. Total base construction costs for the Lead Module, Prototype and Replica Plants are $703, $1,537, and $1,313 million, respectively.

3.2 OVERNIGHT CONSTRUCTION COSTS

Overnight construction costs are obtained by adding contingency to the base construction costs. The MHTGR-SC cost estimate is based on nearly 1500 line item entries defining equipment, systems, bulk commodities, with their associated quantities, unit costs and installation manhours. Each of these line items carries a contingency factor to achieve a 50% confidence estimate. Table 3-12 provides a breakdown of MHTGR-SC contingency costs by three digit cost account for the Lead Module, Prototype, Replica, and Target Plants. These costs were calculated by summing all the individual line item contingencies, and the percentages were calculated by dividing the total account contingency by the account base construction cost. The total contingency estimated for the MHTGR-SC Lead Module is $129.4 million or 18.4% of total base construction costs. The MHTGR-SC Target Plant contingency is estimated to be $231.9 million or 19.0% of total base construction costs.

The Reference 3 Guidelines specified a default contingency of 25% for nuclear and 15% for conventional construction items and allows insertion of different contingencies if justified. Many of the accounts show the default 15% contingency and most other accounts have a contingency between 15% and 25% due to the combination of nuclear and conventional construction items. Major primary system components including the reactor and steam generator vessels were assigned a 15% contingency based on ABB/CENP's experience with large nuclear class vessels for LWR's. A 20% contingency was assigned to the steam generator and shutdown cooling heat exchangers for the same reason. A 25% contingency was applied to all reactor system components and the reactor service equipment received a much higher average contingency (32-34%) due to perceived uncertainties in the estimate with some items carrying a 50% contingency. The average contingency percentage on each account varies slightly from plant to plant in Table 3-12 due to the learning applied and the line item contingencies assigned. The contingency applied in this table does not include an allowance for indeterminates, which is already included in the base construction cost estimate.

3.3 TOTAL CAPITAL COSTS

The cost of invested capital is added to the overnight capital costs to account for estimated plant cash flows and the time value of money. Allowance for funds used during construction (AFUDC) includes the interest paid on debt and preferred stock and a return on investment for common stock. The cost of money identified in Table 1-6 is used to calculate interest during construction. The methodology for calculating interest during construction (IDC) is specified in References 2 and 3. Based on an assumed utility financial structure, the average cost of money before taxes is 11.35%, or 6.05% real (inflation-adjusted).

Table 3-13(a), 3-13(b), and 3-13(c) summarize the Prototype, Replica, and Target Plant capital cost estimates, respectively, including capital cost estimate breakdown at the 2 digit account level, contingency, and interest during construction. Based on the quarterly cash flows provided for each plant, the interest during construction is estimated to be $358 million for the Prototype Plant, $195 million for the Replica Plant, and $176 million for the Target Plant. Interest during construction costs for the Prototype Plant

were calculated using the utility financial structure and average cost of money presented in Table 1-6. It should be noted that the Reference MHTGR-SC deployment scenario assumes government ownership of the Lead Module and interest during construction on the Lead Module would not be ordinarily included on a government project. For the purposes of consistency the Lead Module interest during construction was included in the Prototype Plant as if all four modules were constructed by an investor owned utility with the Table 1-6 financial structure. The resultant total capital cost estimates for the MHTGR-SC Prototype Plant is $2,184 million or $3,153/kW. The Replica Plant total capital plant cost is reduced to $1,759 million or $2,539/kW resulting from elimination of Lead Module design and factory FOAKs, reductions in the overall construction schedule, and the impact of learning on MHTGR specific equipment and field installation labor.

The MHTGR-SC Target Plant quarterly cash flows are presented in Table 3-14. Cash flows and interest during construction (AFUDC) are presented in constant 1992$ and escalated as-spent dollars which incorporates the 5% per year groundrule inflation rate. Note that the four individual modules are placed in service on two month intervals in the last three quarterly cash flows. the "plant in service" line reflects the capital cost placed in the rate base as the modules are placed in commercial operation. For the MHTGR-SC Target Plant, representing the 25th through 28th reactor modules, total capital costs are estimated to be $1,626 million or $2,347/kW. The Target Plant cost reductions are achieved through additional learning on factory fabricated equipment and field installation labor.

3.4 COMPARISON WITH PRIOR ESTIMATES

Tables 3-13(a), 3-13(b), and 3-13(c) also compare the current cost estimates with prior estimates published in the 1990 Cost Reduction Study (CRS), Reference 5, and the previous MHTGR cost estimate report (CER), Reference 1, for the Prototype, Replica, and Target Plants, respectively. The 1990 CRS estimate for the 4x450 MWt, 692 MWe design was developed from the CER estimate for the 4x350 MWt, 538 MWe MHTGR-SC design. A number of design changes have been incorporated in the Reference design resulting in higher MHTGR unit costs relative to the CRS estimate.

The major increases in Prototype Plant direct costs occur in the nuclear island structures and improvements, Account 21, where costs have increased by over 50%. This increase is due to increased quantities of building materials incorporated into a stiffer, stronger reactor building design to reduce reactor plant equipment loads, the incorporation of venting and filtering to further reduce offsite doses in the event of primary system leaks, and the use of higher labor installation rates (lower productivities). Reactor plant equipment costs also increased by 12%, primarily due to updated metallic reactor internals cost estimates based on work performed on the NPR and less learning applied to recover vessel and heat exchanger facility investments. Prototype Plant indirect costs also escalated substantially, with cost increases near 60% in construction services, home office engineering, and field office engineering. Most of the increase was associated with the nuclear island scope estimated by BNI, where the algorithm used to calculate indirects is directly related to field labor costs. The increased structural material quantities combined with higher labor installation rates led to the higher calculated NI indirect costs.

Relative to the 1990 CER report, Prototype Plant total capital costs increased 31%, but unit costs only increased 1.4%. Large increases in the reactor plant and turbine equipment accounts were expected due to the 28% increase in thermal power capability. An increase of nearly 30% in structures and improvements is offset somewhat by a change in construction code adopted for the MHTGR reactor building during the Cost Reduction Study and incorporated in the current design. ACI 318 code construction is assumed to be adequate to maintain structural integrity of the MHTGR reactor building and is consistent with past nuclear plant construction practice for buildings not designed to be pressure retaining structures. ACI 349 code construction would be required on nuclear plant structures designed to be pressure retaining structures, such as a LWR containment building. Indirect costs increased substantially from the 1990 CER report reflecting increases in labor cost and an updated assessment of FOAK engineering costs. Application of the ACI 349 code would increase MHTGR direct costs by approximately $40 million.

MHTGR-SC Target Plant total capital costs, Table 3-13(c), also reflect substantial increases in the structures and improvements and indirect costs for the reasons noted above. Reactor plant equipment costs also increased over 26% over CRS costs in the current estimate. This increase reflects a combination of higher equipment cost estimates, less learning applied to vessels and heat exchangers, and lower factory FOAKS in the current estimate which resulted in a smaller percentage increase in the Prototype Plant costs. While base construction costs increased 22% relative to the 1990 CRS, contingency increased only 16% reflecting, in part, improved design definition and reduced uncertainty.

TABLE 3–1(a)
MHTGR–SC LEAD MODULE BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
21	STRUCTURES & IMPROVEMENTS	3,755,500	1,219,839	29,643,893	22,134,895	55,534,288	4,798,365	350,275	8,846,670	5,199,257	18,844,292	74,378,580
22	REACTOR PLANT EQUIPMENT	188,480,050	326,955	8,273,141	3,835,434	200,588,625	840,900	11,907	295,308	176,919	1,313,127	201,901,752
23	TURBINE PLANT EQUIPMENT	0	5,480	145,822	44,000	189,822	39,173,027	312,911	7,781,823	1,838,329	48,793,179	48,983,001
24	ELECTRIC PLANT EQUIPMENT	1,527,150	227,400	6,128,431	6,136	7,661,717	5,811,000	70,703	1,896,893	1,436,106	9,144,001	16,805,718
25	MISCELLANEOUS PLANT EQUIPMENT	1,929,500	291,714	7,307,818	4,209,311	13,446,329	9,909,250	356,001	8,816,659	3,429,530	22,155,439	35,601,768
26	HEAT REJECTION SYSTEM	0	0	0	0	0	7,584,600	207,852	5,200,161	2,729,258	15,514,019	15,514,019
2	TOTAL DIRECT COSTS	195,692,200	2,071,388	51,498,805	30,229,776	277,420,781	68,117,142	1,309,649	32,837,514	16,809,401	117,764,057	395,184,838
91	CONSTRUCTION SERVICES	0	0	36,733,785	15,743,051	52,476,836	0	0	0	22,320,000	22,320,000	74,796,836
92	ENGINEERING AND HOME OFFICE SERVICES	21,644,000	0	79,282,372	0	100,926,372	0	0	15,500,000	992,500	16,492,500	117,418,872
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	17,133,062	3,263,440	20,396,502	0	0	0	5,106,250	5,106,250	25,502,752
94	OWNER'S COSTS	0	0	0	0	0	0	0	53,926,779	35,962,842	89,889,622	89,889,622
9	TOTAL INDIRECT COSTS	21,644,000	0	133,149,219	19,006,491	173,799,710	0	0	69,426,779	64,381,592	133,808,372	307,608,082
	TOTAL BASE CONSTRUCTION COST	217,336,200	2,071,388	184,648,024	49,236,267	451,220,491	68,117,142	1,309,649	102,264,293	81,190,993	251,572,429	702,792,920

TABLE 3–1(b)
MHTGR–SC PROTOTYPE PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
21	STRUCTURES & IMPROVEMENTS	12,268,000	2,615,613	63,458,884	47,479,250	123,206,134	6,770,700	578,583	14,741,537	12,653,651	34,165,888	157,372,022
22	REACTOR PLANT EQUIPMENT	491,579,042	813,362	20,656,679	9,340,159	521,575,880	840,900	11,907	295,308	176,919	1,313,127	522,889,007
23	TURBINE PLANT EQUIPMENT	0	5,480	145,822	44,000	189,822	131,960,028	1,041,804	25,912,110	7,106,778	164,998,916	165,188,738
24	ELECTRIC PLANT EQUIPMENT	6,108,600	790,759	21,310,953	24,544	27,444,097	16,649,550	194,233	5,226,020	5,436,692	27,312,262	54,756,359
25	MISCELLANEOUS PLANT EQUIPMENT	3,280,040	325,291	8,135,154	5,580,101	16,995,295	10,900,750	395,372	9,817,061	3,578,867	24,296,998	41,291,993
26	HEAT REJECTION SYSTEM	0	0	0	0	0	15,428,000	398,412	9,974,061	5,840,966	31,243,027	31,243,027
2	TOTAL DIRECT COSTS	513,235,682	4,550,505	113,707,492	62,468,054	689,411,228	182,569,928	2,620,311	65,966,117	36,793,573	285,329,618	974,740,846
91	CONSTRUCTION SERVICES	0	0	72,633,526	31,128,654	103,762,181	0	0	0	38,040,000	38,040,000	141,802,181
92	ENGINEERING AND HOME OFFICE SERVICES	52,719,324	0	104,427,129	0	157,146,453	0	0	15,500,000	3,970,000	19,470,000	176,616,453
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	36,473,049	6,947,248	43,420,297	0	0	0	20,425,000	20,425,000	63,845,297
94	OWNER'S COSTS	0	0	0	0	0	0	0	82,575,805	97,021,250	179,597,055	179,597,055
9	TOTAL INDIRECT COSTS	52,719,324	0	213,533,705	38,075,902	304,328,931	0	0	98,075,805	159,456,250	257,532,055	561,860,986
	TOTAL BASE CONSTRUCTION COST	565,955,005	4,550,505	327,241,197	100,543,956	993,740,158	182,569,928	2,620,311	164,041,922	196,249,823	542,861,673	1,536,601,831

TABLE 3–1(c)
MHTGR–SC REPLICA PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
21	STRUCTURES & IMPROVEMENTS	12,268,000	2,453,876	59,537,837	47,479,250	119,285,087	6,770,700	549,567	13,996,297	12,653,651	33,420,648	152,705,735
22	REACTOR PLANT EQUIPMENT	433,274,347	758,926	19,272,169	9,340,159	461,886,675	840,900	11,669	289,407	176,919	1,307,226	463,193,901
23	TURBINE PLANT EQUIPMENT	0	5,370	142,896	44,000	186,896	125,232,028	965,054	24,003,113	7,106,778	156,341,919	156,528,815
24	ELECTRIC PLANT EQUIPMENT	6,106,600	731,896	19,724,599	24,544	25,857,743	16,649,550	180,909	4,867,117	5,436,692	26,953,359	52,811,102
25	MISCELLANEOUS PLANT EQUIPMENT	3,280,040	316,219	7,909,194	5,580,101	16,769,335	10,900,750	384,434	9,543,761	3,578,557	24,023,078	40,792,413
26	HEAT REJECTION SYSTEM	0	0	0	0	0	15,428,000	368,902	9,235,217	5,840,966	30,504,183	30,504,183
2	TOTAL DIRECT COSTS	454,930,987	4,266,287	106,586,695	62,468,054	623,985,736	175,821,928	2,460,535	61,934,912	36,793,573	274,550,413	898,536,149
91	CONSTRUCTION SERVICES	0	0	56,685,854	24,293,937	80,979,791	0	0	0	38,040,000	38,040,000	119,019,791
92	ENGINEERING AND HOME OFFICE SERVICES	30,098,323	0	38,910,481	0	69,008,803	0	0	0	3,970,000	3,970,000	72,978,803
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	31,653,985	6,029,330	37,683,315	0	0	0	20,425,000	20,425,000	58,108,315
94	OWNER'S COSTS	0	0	0	0	0	0	0	63,243,446	101,054,605	164,298,051	164,298,051
9	TOTAL INDIRECT COSTS	30,098,323	0	127,250,319	30,323,268	187,671,910	0	0	63,243,446	163,489,605	226,733,051	414,404,961
	TOTAL BASE CONSTRUCTION COST	485,029,310	4,266,287	233,837,014	92,791,322	811,657,646	175,821,928	2,460,535	125,178,358	200,283,178	501,283,464	1,312,941,110

TABLE 3–1(d)
MHTGR–SC TARGET PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
21	STRUCTURES & IMPROVEMENTS	12,268,000	2,365,884	57,402,910	47,479,250	117,150,160	6,770,700	529,860	13,494,397	12,653,651	32,918,748	150,068,908
22	REACTOR PLANT EQUIPMENT	394,006,560	731,711	18,561,067	9,340,159	421,929,786	840,900	11,250	279,012	176,919	1,296,831	423,226,617
23	TURBINE PLANT EQUIPMENT	0	5,178	137,787	44,000	181,787	125,232,028	930,459	23,142,655	7,106,778	155,481,461	155,663,248
24	ELECTRIC PLANT EQUIPMENT	6,106,600	705,647	19,017,188	24,544	25,150,332	16,649,550	174,415	4,692,392	5,436,692	26,778,634	51,928,966
25	MISCELLANEOUS PLANT EQUIPMENT	3,280,040	304,883	7,625,657	5,580,101	16,485,798	10,900,750	370,643	9,201,393	3,578,557	23,680,710	40,166,508
26	HEAT REJECTION SYSTEM	0	0	0	0	0	15,428,000	355,672	8,904,002	5,840,966	30,172,968	30,172,968
2	TOTAL DIRECT COSTS	415,665,200	4,113,303	102,764,609	62,468,054	580,897,863	175,821,928	2,372,299	59,713,851	36,793,573	272,329,352	853,227,215
91	CONSTRUCTION SERVICES	0	0	55,027,068	23,583,029	78,610,098	0	0	0	38,040,000	38,040,000	116,650,098
92	ENGINEERING AND HOME OFFICE SERVICES	17,117,918	0	38,617,587	0	55,735,505	0	0	0	3,970,000	3,970,000	59,705,505
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	30,594,502	5,827,524	36,422,027	0	0	0	20,425,000	20,425,000	56,847,027
94	OWNER'S COSTS	0	0	0	0	0	0	0	41,112,472	90,865,840	131,978,313	131,978,313
9	TOTAL INDIRECT COSTS	17,117,918	0	124,239,158	29,410,554	170,767,629	0	0	41,112,472	153,300,840	194,413,313	365,180,942
	TOTAL BASE CONSTRUCTION COST	432,783,118	4,113,303	227,003,767	91,878,608	751,665,492	175,821,928	2,372,299	100,826,323	190,094,413	466,742,665	1,218,408,156

TABLE 3–2
MHTGR–SC PLANT COSTS AND % BY ACCOUNT

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE								% CHANGE	
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	PROTOTYPE 1992$	PROTOTYPE %	REPLICA 1992$	REPLICA %	TARGET 1992$	TARGET %	PROTOTYPE TO TARGET	REPLICA TO TARGET
20	LAND & LAND RIGHTS	2,000,000	0.1%	2,000,000	0.2%	2,000,000	0.2%	0.0%	0.0%
211	YARDWORK	7,293,886	0.5%	7,203,883	0.5%	7,045,691	0.6%	−3.4%	−2.2%
212	REACTOR COMPLEX	117,606,194	7.7%	113,752,882	8.7%	111,733,668	9.2%	−5.0%	−1.8%
213	TURBINE COMPLEX	24,440,533	1.6%	23,792,405	1.8%	23,461,555	1.9%	−4.0%	−1.4%
214	OPERATIONS CENTER	4,446,469	0.3%	4,411,344	0.3%	4,346,034	0.4%	−2.3%	−1.5%
215	REMOTE SHUTDOWN BUILDING	149,970	0.0%	148,185	0.0%	145,033	0.0%	−3.3%	−2.1%
216	OTHER BUILDINGS	3,430,970	0.2%	3,397,036	0.3%	3,336,927	0.3%	−2.7%	−1.8%
21	STRUCTURES & IMPROVEMENTS	157,372,022	10.2%	152,705,735	11.6%	150,068,908	12.3%	−4.6%	−1.7%
221	REACTOR SYSTEM	146,039,998	9.5%	125,305,855	9.5%	110,645,574	9.1%	−24.2%	−11.7%
222	VESSEL SYSTEM	137,003,284	8.9%	127,020,579	9.7%	120,802,079	9.9%	−11.8%	−4.9%
223	HEAT TRANSPORT SYSTEM	114,415,068	7.4%	99,718,145	7.6%	90,213,463	7.4%	−21.2%	−9.5%
224	SHUTDOWN COOLING SYSTEM	16,802,492	1.1%	14,225,349	1.1%	12,899,013	1.1%	−23.2%	−9.3%
225	SHUTDOWN COOLING WATER SYSTEM	4,306,570	0.3%	3,986,647	0.3%	3,671,601	0.3%	−14.7%	−7.9%
226	REACTOR CAVITY COOLING SYSTEM	17,149,794	1.1%	15,515,701	1.2%	14,330,012	1.2%	−16.4%	−7.6%
227	REACTOR SERVICE SYSTEM	58,247,373	3.8%	52,606,391	4.0%	47,872,968	3.9%	−17.8%	−9.0%
228	REACTOR CONTROL, PROTECTION & MONITORING	15,267,327	1.0%	13,883,237	1.1%	12,760,634	1.0%	−16.4%	−8.1%
229	REACTOR PLANT MISCELLANEOUS	13,657,100	0.9%	10,931,998	0.8%	10,031,273	0.8%	−26.5%	−8.2%
22	REACTOR PLANT EQUIPMENT	522,889,007	34.0%	463,193,901	35.3%	423,226,617	34.7%	−19.1%	−8.6%
231	TURBINE GENERATOR & AUXILIARIES	86,524,974	5.6%	79,175,902	6.0%	78,902,241	6.5%	−8.8%	−0.3%
233	MAIN & AUXILIARY STEAM SYSTEM	14,867,476	1.0%	14,561,983	1.1%	14,425,720	1.2%	−3.0%	−0.9%
234	FEEDWATER & CONDENSATE SYSTEM	34,769,738	2.3%	34,048,750	2.6%	33,723,708	2.8%	−3.0%	−1.0%
235	STARTUP & SHUTDOWN SYSTEM	0	0.0%	0	0.0%	0	0.0%	0.0%	0.0%
236	TURBINE PLANT SAMPLING SYSTEM	2,673,283	0.2%	2,637,768	0.2%	2,621,910	0.2%	−1.9%	−0.6%
237	ECA CONTROL, DATA & INSTRUMENTATION	26,353,267	1.7%	26,104,412	2.0%	25,969,669	2.1%	−1.4%	−0.4%
23	TURBINE PLANT EQUIPMENT	165,188,738	10.8%	156,528,815	11.9%	155,663,248	12.8%	−5.8%	−0.6%
241	SWITCHGEAR	7,361,977	0.5%	7,267,865	0.6%	7,254,527	0.6%	−1.5%	−0.5%
242	STATION SERVICE EQUIPMENT	13,997,832	0.9%	13,888,619	1.1%	13,833,124	1.1%	−1.2%	−0.4%
243	SWITCHBOARDS	4,106,724	0.3%	4,098,023	0.3%	4,094,085	0.3%	−0.3%	−0.1%
244	PROTECTIVE EQUIPMENT	490,835	0.0%	484,366	0.0%	473,829	0.0%	−3.5%	−2.2%
245	ELECTRIC STRUCTURES & WIRING CONTAINERS	14,430,149	0.9%	13,429,632	1.0%	12,983,583	1.1%	−10.0%	−3.3%
246	POWER AND CONTROL WIRING	14,368,842	0.9%	13,622,597	1.0%	13,289,818	1.1%	−7.5%	−2.4%
24	ELECTRIC PLANT EQUIPMENT	54,756,359	3.6%	52,811,102	4.0%	51,928,966	4.3%	−5.2%	−1.7%

TABLE 3–2
MHTGR–SC PLANT COSTS AND % BY ACCOUNT

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE								% CHANGE	
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	PROTOTYPE 1992$	PROTOTYPE %	REPLICA 1992$	REPLICA %	TARGET 1992$	TARGET %	PROTOTYPE TO TARGET	REPLICA TO TARGET
251	TRANSPORTATION AND LIFT EQUIPMENT	2,640,696	0.2%	2,624,005	0.2%	2,610,992	0.2%	−1.1%	−0.5%
252	AIR, WATER, AND STEAM SERVICE SYSTEM	32,081,945	2.1%	31,649,226	2.4%	31,093,933	2.6%	−3.1%	−1.8%
253	COMMUNICATIONS AND SECURITY EQUIPMENT	4,661,137	0.3%	4,614,021	0.4%	4,561,332	0.4%	−2.1%	−1.1%
254	FURNISHINGS AND FIXTURES	1,907,915	0.1%	1,905,161	0.1%	1,900,251	0.2%	−0.4%	−0.3%
25	MISCELLANEOUS PLANT EQUIPMENT	41,291,693	2.7%	40,792,413	3.1%	40,166,508	3.3%	−2.7%	−1.5%
261	CIRCULATING AND SERVICE WATER PUMPHOUSE	509,941	0.0%	487,016	0.0%	476,796	0.0%	−6.5%	−2.1%
262	ECA COOLING WATER SYSTEMS	3,725,139	0.2%	3,602,651	0.3%	3,548,103	0.3%	−4.8%	−1.5%
263	CIRCULATING AND SERVICE WATER SYSTEM	27,007,947	1.8%	26,414,516	2.0%	26,148,069	2.1%	−3.2%	−1.0%
26	HEAT REJECTION SYSTEM	31,243,027	2.0%	30,504,183	2.3%	30,172,968	2.5%	−3.4%	−1.1%
2	TOTAL DIRECT COSTS	974,740,846	63.4%	898,536,149	68.4%	853,227,215	70.0%	−12.5%	−5.0%
911	TEMPORARY CONSTRUCTION FACILITIES	56,148,225	3.7%	45,440,502	3.5%	44,326,746	3.6%	−21.1%	−2.5%
912	CONSTRUCTION TOOLS AND EQUIPMENT	34,602,923	2.3%	29,135,150	2.2%	28,586,423	2.3%	−17.4%	−2.0%
913	PAYROLL INSURANCE AND TAXES	49,053,411	3.2%	42,674,342	3.3%	42,010,827	3.4%	−14.4%	−1.6%
914	PERMITS, INSURANCE, AND LOCAL TAXES	1,997,622	0.1%	1,769,798	0.1%	1,746,101	0.1%	−12.6%	−1.3%
91	CONSTRUCTION SERVICES	141,802,181	9.2%	119,019,791	9.1%	116,650,098	9.6%	−17.7%	−2.0%
920	REACTOR MODULE ENGINEERING AND SERVICES	52,719,324	3.4%	30,098,323	2.3%	17,117,918	1.4%	−67.5%	−43.1%
921	PLANT ENGINEERING AND SERVICES	100,920,347	6.6%	31,782,860	2.4%	31,583,190	2.6%	−68.7%	−0.7%
922	HOME OFFICE QUALITY ASSURANCE	1,610,678	0.1%	972,762	0.1%	965,440	0.1%	−40.1%	−0.8%
923	HOME OFFICE PROJECT & CONSTRUCTION MGMT.	21,366,104	1.4%	10,124,858	0.8%	10,058,957	0.8%	−52.9%	−0.7%
92	ENGINEERING AND HOME OFFICE SERVICES	176,616,453	11.5%	72,978,803	5.6%	59,705,505	4.9%	−66.2%	−18.2%
931	FIELD OFFICE EXPENSES	6,978,842	0.5%	6,175,664	0.5%	5,999,084	0.5%	−14.0%	−2.9%
932	FIELD JOB SUPERVISION	43,181,163	2.8%	40,025,823	3.0%	39,332,115	3.2%	−8.9%	−1.7%
933	FIELD QUALITY ASSURANCE/QUALITY CONTROL	2,171,015	0.1%	1,884,166	0.1%	1,821,101	0.1%	−16.1%	−3.3%
934	PLANT STARTUP AND TEST	11,514,277	0.7%	10,022,662	0.8%	9,694,727	0.8%	−15.8%	−3.3%
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	63,845,297	4.2%	58,108,315	4.4%	56,847,027	4.7%	−11.0%	−2.2%
941	PROJECT MANAGEMENT EXPENSES	21,969,402	1.4%	9,672,650	0.7%	7,917,168	0.6%	−64.0%	−18.1%
942	FEES, TAXES, AND INSURANCE	52,150,000	3.4%	57,550,000	4.4%	50,760,000	4.2%	−2.7%	−11.8%
943	SPARE PARTS AND CAPITAL EQUIPMENT	31,705,610	2.1%	31,112,018	2.4%	30,332,019	2.5%	−4.3%	−2.5%
944	STAFF TRAINING AND STARTUP	57,148,514	3.7%	52,039,725	4.0%	32,375,433	2.7%	−43.3%	−37.8%
945	GENERAL & ADMINISTRATIVE	16,623,529	1.1%	13,923,659	1.1%	10,593,693	0.9%	−36.3%	−23.9%
94	OWNER'S COSTS	179,597,055	11.7%	164,298,051	12.5%	131,978,313	10.8%	−26.5%	−19.7%
9	TOTAL INDIRECT COSTS	561,860,986	36.6%	414,404,961	31.6%	365,180,942	30.0%	−35.0%	−11.9%
	TOTAL BASE CONSTRUCTION COST	1,536,601,831	100.0%	1,312,941,110	100.0%	1,218,408,156	100.0%	−20.7%	−7.2%

TABLE 3–3
SUMMARY MHTGR–SC COSTS BY COST CATEGORY

COST CATEGORY	PROTOTYPE		REPLICA		TARGET		% CHANGE	
	COST	% OF TOTAL	COST	% OF TOTAL	COST	% OF TOTAL	PROTOTYPE TO TARGET	REPLICA TO TARGET
NUCLEAR ISLAND (NI)								
FACTORY EQUIPMENT	513,235,682	33.4%	454,930,987	34.6%	415,665,200	34.1%	−19.0%	−8.6%
SITE LABOR COST	113,707,492	7.4%	106,586,695	8.1%	102,764,609	8.4%	−9.6%	−3.6%
SITE MATERIAL	62,468,054	4.1%	62,468,054	4.8%	62,468,054	5.1%	0.0%	0.0%
TOTAL NI DIRECT COST	689,411,228	44.9%	623,985,736	47.5%	580,897,863	47.7%	−15.7%	−6.9%
CONSTRUCTION SERVICES	103,762,181	6.8%	80,979,791	6.2%	78,610,098	6.5%	−24.2%	−2.9%
HOME OFFICE ENGINEERING & SERVICES	157,146,453	10.2%	69,008,803	5.3%	55,735,505	4.6%	−64.5%	−19.2%
FIELD OFFICE AND SERVICES	43,420,297	2.8%	37,683,315	2.9%	36,422,027	3.0%	−16.1%	−3.3%
TOTAL NI INDIRECT COST	304,328,931	19.8%	187,671,910	14.3%	170,767,629	14.0%	−43.9%	−9.0%
TOTAL NI BASE CONSTRUCTION COST	993,740,158	64.7%	811,657,646	61.8%	751,665,492	61.7%	−24.4%	−7.4%
ENERGY CONVERSION AREA (ECA)								
FACTORY EQUIPMENT	182,569,928	11.9%	175,821,928	13.4%	175,821,928	14.4%	−3.7%	0.0%
SITE LABOR COST	65,966,117	4.3%	61,934,912	4.7%	59,713,851	4.9%	−9.5%	−3.6%
SITE MATERIAL	36,793,573	2.4%	36,793,573	2.8%	36,793,573	3.0%	0.0%	0.0%
TOTAL ECA DIRECT COST	285,329,618	18.6%	274,550,413	20.9%	272,329,352	22.4%	−4.6%	−0.8%
CONSTRUCTION SERVICES	38,040,000	2.5%	38,040,000	2.9%	38,040,000	3.1%	0.0%	0.0%
HOME OFFICE ENGINEERING & SERVICES	19,470,000	1.3%	3,970,000	0.3%	3,970,000	0.3%	−79.6%	0.0%
FIELD OFFICE AND SERVICES	20,425,000	1.3%	20,425,000	1.6%	20,425,000	1.7%	0.0%	0.0%
TOTAL ECA INDIRECT COST	77,935,000	5.1%	62,435,000	4.8%	62,435,000	5.1%	−19.9%	0.0%
TOTAL ECA BASE CONSTRUCTION COST	363,264,618	23.6%	336,985,413	25.7%	334,764,352	27.5%	−7.8%	−0.7%
TOTAL PLANT								
FACTORY EQUIPMENT	695,805,610	45.3%	630,752,915	48.0%	591,487,128	48.5%	−15.0%	−6.2%
SITE LABOR COST	179,673,609	11.7%	168,521,607	12.8%	162,478,460	13.3%	−9.6%	−3.6%
SITE MATERIAL	99,261,627	6.5%	99,261,627	7.6%	99,261,627	8.1%	0.0%	0.0%
TOTAL PLANT DIRECT COST	974,740,846	63.4%	898,536,149	68.4%	853,227,215	70.0%	−12.5%	−5.0%
CONSTRUCTION SERVICES	141,802,181	9.2%	119,019,791	9.1%	116,650,098	9.6%	−17.7%	−2.0%
HOME OFFICE ENGINEERING & SERVICES	176,616,453	11.5%	72,978,803	5.6%	59,705,505	4.9%	−66.2%	−18.2%
FIELD OFFICE AND SERVICES	63,845,297	4.2%	58,108,315	4.4%	56,847,027	4.7%	−11.0%	−2.2%
OWNER'S COSTS	179,597,055	4.2%	164,298,051	4.4%	131,978,313	4.7%	−26.5%	−19.7%
TOTAL PLANT INDIRECT COST	561,860,986	36.6%	414,404,961	31.6%	365,180,942	30.0%	−35.0%	−11.9%
TOTAL PLANT CONSTRUCTION COST	1,536,601,831	100.0%	1,312,941,110	100.0%	1,218,408,156	100.0%	−20.7%	−7.2%

TABLE 3–4(a)
MHTGR–SC LEAD MODULE CREW MANHOURS

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	ENGINEER CREW	STRUCTURAL CREW	CONCRETE CREW	PIPING CREW	MECHANICAL CREW	ELECTRICAL CREW	INSTRUMENT CREW	TOTAL MANHOURS
	NUCLEAR ISLAND								
21	STRUCTURES & IMPROVEMENTS	163,874	169,287	751,298	21,982	5,755	107,643	0	1,219,839
22	REACTOR PLANT EQUIPMENT	34	33,271	318	107,410	127,112	27,354	31,456	326,955
23	TURBINE PLANT EQUIPMENT	0	0	0	0	0	0	5,480	5,480
24	ELECTRIC PLANT EQUIPMENT	0	0	0	0	0	227,400	0	227,400
25	MISCELLANEOUS PLANT EQUIPMENT	0	1,968	0	246,876	29,808	0	13,062	291,714
26	HEAT REJECTION SYSTEM								0
2	SUBTOTAL NUCLEAR ISLAND	163,908	204,526	751,616	376,268	162,675	362,397	49,998	2,071,388
	ENERGY CONVERSION AREA								
21	STRUCTURES & IMPROVEMENTS	28,168	139,793	128,282	0	8,371	45,661	0	350,275
22	REACTOR PLANT EQUIPMENT	0	0	0	6,797	5,110	0	0	11,907
23	TURBINE PLANT EQUIPMENT	362	460	24,346	106,835	145,208	0	35,700	312,911
24	ELECTRIC PLANT EQUIPMENT	1,131	550	0	980	517	67,525	0	70,703
25	MISCELLANEOUS PLANT EQUIPMENT	5,501	195	3,169	27,533	282,301	37,302	0	356,001
26	HEAT REJECTION SYSTEM	16,012	5,200	39,226	57,151	37,593	52,670	0	207,852
2	SUBTOTAL ENERGY CONVERSION AREA	51,174	146,198	195,023	199,296	479,100	203,158	35,700	1,309,649
	TOTAL MANHOURS	215,082	350,724	946,639	575,564	641,775	565,555	85,698	3,381,037

TABLE 3–4(b)
MHTGR–SC PROTOTYPE PLANT CREW MANHOURS

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	ENGINEER CREW	STRUCTURAL CREW	CONCRETE CREW	PIPING CREW	MECHANICAL CREW	ELECTRICAL CREW	INSTRUMENT CREW	TOTAL MANHOURS
	NUCLEAR ISLAND								
21	STRUCTURES & IMPROVEMENTS	280,147	283,615	1,749,248	51,666	17,535	233,402	0	2,615,613
22	REACTOR PLANT EQUIPMENT	34	107,323	318	226,258	315,527	85,307	78,595	813,362
23	TURBINE PLANT EQUIPMENT	0	0	0	0	0	0	5,480	5,480
24	ELECTRIC PLANT EQUIPMENT	0	0	0	0	0	790,759	0	790,759
25	MISCELLANEOUS PLANT EQUIPMENT	0	1,968	0	246,876	61,165	0	15,282	325,291
26	HEAT REJECTION SYSTEM								0
2	SUBTOTAL NUCLEAR ISLAND	280,181	392,906	1,749,566	524,800	394,227	1,109,468	99,357	4,550,505
	ENERGY CONVERSION AREA								
21	STRUCTURES & IMPROVEMENTS	35,387	253,148	183,396	0	16,670	89,982	0	578,583
22	REACTOR PLANT EQUIPMENT	0	0	0	6,797	5,110	0	0	11,907
23	TURBINE PLANT EQUIPMENT	1,227	1,055	83,747	346,422	485,210	0	124,143	1,041,804
24	ELECTRIC PLANT EQUIPMENT	1,131	550	0	980	517	191,055	0	194,233
25	MISCELLANEOUS PLANT EQUIPMENT	5,501	542	3,169	56,434	284,249	45,477	0	395,372
26	HEAT REJECTION SYSTEM	28,388	12,425	69,546	129,962	64,707	93,384	0	398,412
2	SUBTOTAL ENERGY CONVERSION AREA	71,634	267,720	339,858	540,595	856,463	419,898	124,143	2,620,311
	TOTAL MANHOURS	351,815	660,626	2,089,424	1,065,395	1,250,690	1,529,366	223,500	7,170,816

TABLE 3–4(c)
MHTGR–SC REPLICA PLANT CREW MANHOURS

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	ENGINEER CREW	STRUCTURAL CREW	CONCRETE CREW	PIPING CREW	MECHANICAL CREW	ELECTRICAL CREW	INSTRUMENT CREW	TOTAL MANHOURS
	NUCLEAR ISLAND								
21	STRUCTURES & IMPROVEMENTS	265,461	268,615	1,636,231	48,366	16,284	218,919	0	2,453,876
22	REACTOR PLANT EQUIPMENT	34	99,517	313	211,779	294,750	79,132	73,401	758,926
23	TURBINE PLANT EQUIPMENT	0	0	0	0	0	0	5,370	5,370
24	ELECTRIC PLANT EQUIPMENT	0	0	0	0	0	731,896	0	731,896
25	MISCELLANEOUS PLANT EQUIPMENT	0	1,928	0	241,938	57,546	0	14,807	316,219
26	HEAT REJECTION SYSTEM								0
2	SUBTOTAL NUCLEAR ISLAND	265,495	370,060	1,636,544	502,083	368,580	1,029,947	93,578	4,266,287
	ENERGY CONVERSION AREA								
21	STRUCTURES & IMPROVEMENTS	34,129	239,423	175,515	0	15,704	84,796	0	549,567
22	REACTOR PLANT EQUIPMENT	0	0	0	6,661	5,008	0	0	11,669
23	TURBINE PLANT EQUIPMENT	1,135	988	77,515	321,077	449,438	0	114,901	965,054
24	ELECTRIC PLANT EQUIPMENT	1,108	539	0	960	507	177,795	0	180,909
25	MISCELLANEOUS PLANT EQUIPMENT	5,393	505	3,105	53,097	278,391	43,943	0	384,434
26	HEAT REJECTION SYSTEM	26,275	11,499	64,368	120,288	60,039	86,433	0	368,902
2	SUBTOTAL ENERGY CONVERSION AREA	68,040	252,954	320,503	502,083	809,087	392,967	114,901	2,460,535
	TOTAL MANHOURS	333,535	623,014	1,957,047	1,004,166	1,177,667	1,422,914	208,479	6,726,822

TABLE 3–4(d)
MHTGR–SC TARGET PLANT CREW MANHOURS

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	ENGINEER CREW	STRUCTURAL CREW	CONCRETE CREW	PIPING CREW	MECHANICAL CREW	ELECTRICAL CREW	INSTRUMENT CREW	TOTAL MANHOURS
	NUCLEAR ISLAND								
21	STRUCTURES & IMPROVEMENTS	255,936	258,979	1,577,564	46,630	15,700	211,075	0	2,365,884
22	REACTOR PLANT EQUIPMENT	32	95,949	300	204,185	284,180	76,293	70,772	731,711
23	TURBINE PLANT EQUIPMENT	0	0	0	0	0	0	5,178	5,178
24	ELECTRIC PLANT EQUIPMENT	0	0	0	0	0	705,647	0	705,647
25	MISCELLANEOUS PLANT EQUIPMENT	0	1,858	0	233,263	55,487	0	14,275	304,883
26	HEAT REJECTION SYSTEM								0
2	SUBTOTAL NUCLEAR ISLAND	255,968	356,786	1,577,864	484,078	355,367	993,015	90,225	4,113,303
	ENERGY CONVERSION AREA								
21	STRUCTURES & IMPROVEMENTS	32,905	230,837	169,225	0	15,138	81,755	0	529,860
22	REACTOR PLANT EQUIPMENT	0	0	0	6,421	4,829	0	0	11,250
23	TURBINE PLANT EQUIPMENT	1,095	953	74,734	309,570	433,326	0	110,781	930,459
24	ELECTRIC PLANT EQUIPMENT	1,069	520	0	926	489	171,411	0	174,415
25	MISCELLANEOUS PLANT EQUIPMENT	5,198	486	2,994	51,193	268,404	42,368	0	370,643
26	HEAT REJECTION SYSTEM	25,335	11,085	62,060	115,974	57,885	83,333	0	355,672
2	SUBTOTAL ENERGY CONVERSION AREA	65,602	243,881	309,013	484,084	780,071	378,867	110,781	2,372,299
	TOTAL MANHOURS	321,570	600,667	1,886,877	968,162	1,135,438	1,371,882	201,006	6,485,602

TABLE 3-5(a)
MHTGR-SC LEAD MODULE CRAFT MANHOURS BY AREA

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	BOILERMAKER	CARPENTER	ELECTRICIAN	IRONWORKER	LABORER	MILLWRIGHT	OPERATING ENGINEER	PIPE FITTER	TEAMSTER	OTHER	TOTALS
	NUCLEAR ISLAND											
21	STRUCTURES & IMPROVEMENTS	3,297	308,984	75,350	279,423	332,178	5,496	125,968	42,438	9,141	37,565	1,219,839
22	REACTOR PLANT EQUIPMENT	16,112	2,420	49,346	35,758	2,094	26,853	37,836	146,942	9,580	16	326,955
23	TURBINE PLANT EQUIPMENT	0	110	5,261	0	55	0	55	0	0	0	5,480
24	ELECTRIC PLANT EQUIPMENT	0	0	159,180	0	0	0	4,548	63,672	0	0	227,400
25	MISCELLANEOUS PLANT EQUIPMENT	37,031	360	12,540	26,164	229	61,719	34,522	110,253	8,897	0	291,714
26	HEAT REJECTION SYSTEM	0	0	0	0	0	0	0	0	0	0	0
2	SUBTOTAL NUCLEAR ISLAND	56,440	311,873	301,676	341,345	334,556	94,067	202,929	363,305	27,617	37,581	2,071,388
	ENERGY CONVERSION AREA											
21	STRUCTURES & IMPROVEMENTS	0	58,302	31,963	130,501	62,375	0	39,411	19,482	1,827	6,414	350,275
22	REACTOR PLANT EQUIPMENT	1,020	0	0	680	0	1,699	1,582	6,467	459	0	11,907
23	TURBINE PLANT EQUIPMENT	16,025	10,475	34,272	15,898	7,901	26,709	36,371	153,559	10,484	1,217	312,911
24	ELECTRIC PLANT EQUIPMENT	147	28	47,268	511	706	245	2,024	19,664	112	0	70,703
25	MISCELLANEOUS PLANT EQUIPMENT	4,130	1,277	26,111	3,533	4,261	6,883	48,508	245,922	15,216	158	356,001
26	HEAT REJECTION SYSTEM	8,573	15,950	36,869	17,460	21,635	14,288	21,896	64,825	4,395	1,961	207,852
2	SUBTOTAL ENERGY CONVERSION AREA	29,894	86,033	176,483	168,583	96,878	49,824	149,792	509,918	32,493	9,751	1,309,649
	TOTAL MANHOURS	86,335	397,906	478,159	509,927	431,434	143,891	352,721	873,223	60,110	47,332	3,381,037

TABLE 3-5(b)
MHTGR-SC PROTOTYPE PLANT CRAFT MANHOURS BY AREA

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	BOILERMAKER	CARPENTER	ELECTRICIAN	IRONWORKER	LABORER	MILLWRIGHT	OPERATING ENGINEER	PIPE FITTER	TEAMSTER	OTHER	TOTALS
	NUCLEAR ISLAND											
21	STRUCTURES & IMPROVEMENTS	7,750	713,880	163,381	567,727	707,043	12,917	241,554	97,464	16,434	87,462	2,615,613
22	REACTOR PLANT EQUIPMENT	33,939	7,065	135,166	103,182	6,268	56,565	93,098	355,498	22,566	16	813,362
23	TURBINE PLANT EQUIPMENT	0	110	5,261	0	55	0	55	0	0	0	5,480
24	ELECTRIC PLANT EQUIPMENT	0	0	553,531	0	0	0	15,815	221,413	0	0	790,759
25	MISCELLANEOUS PLANT EQUIPMENT	37,031	404	14,671	26,164	251	61,719	39,248	135,339	10,465	0	325,291
26	HEAT REJECTION SYSTEM	0	0	0	0	0	0	0	0	0	0	0
2	SUBTOTAL NUCLEAR ISLAND	78,720	721,459	872,010	697,073	713,617	131,200	389,771	809,713	49,464	87,478	4,550,505
	ENERGY CONVERSION AREA											
21	STRUCTURES & IMPROVEMENTS	0	86,016	62,987	226,540	88,908	0	63,828	38,531	2,603	9,170	578,583
22	REACTOR PLANT EQUIPMENT	1,020	0	0	680	0	1,699	1,582	6,467	459	0	11,907
23	TURBINE PLANT EQUIPMENT	51,963	36,034	119,177	52,183	27,154	86,606	120,369	509,416	34,715	4,187	1,041,804
24	ELECTRIC PLANT EQUIPMENT	147	28	133,739	511	706	245	4,495	54,252	112	0	194,233
25	MISCELLANEOUS PLANT EQUIPMENT	8,465	1,295	31,834	6,684	4,278	14,109	52,484	259,885	16,181	158	395,372
26	HEAT REJECTION SYSTEM	19,494	28,440	65,369	36,224	38,518	32,491	42,446	123,400	8,554	3,477	398,412
2	SUBTOTAL ENERGY CONVERSION AREA	81,089	151,812	413,106	322,821	159,565	135,149	285,203	991,950	62,623	16,993	2,620,311
	TOTAL MANHOURS	159,809	873,271	1,285,116	1,019,894	873,183	266,349	674,974	1,801,663	112,087	104,471	7,170,816

TABLE 3-5(c)
MHTGR-SC REPLICA PLANT CRAFT MANHOURS BY AREA

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	BOILERMAKER	CARPENTER	ELECTRICIAN	IRONWORKER	LABORER	MILLWRIGHT	OPERATING ENGINEER	PIPE FITTER	TEAMSTER	OTHER	TOTALS
	NUCLEAR ISLAND											
21	STRUCTURES & IMPROVEMENTS	7,255	667,923	153,243	533,544	663,577	12,092	227,640	91,253	15,538	81,812	2,453,876
22	REACTOR PLANT EQUIPMENT	31,767	6,569	125,857	95,878	5,824	52,945	86,898	332,080	21,093	16	758,926
23	TURBINE PLANT EQUIPMENT	0	107	5,155	0	54	0	54	0	0	0	5,370
24	ELECTRIC PLANT EQUIPMENT	0	0	512,327	0	0	0	14,638	204,931	0	0	731,896
25	MISCELLANEOUS PLANT EQUIPMENT	36,291	393	14,215	25,640	244	60,485	38,102	130,715	10,135	0	316,219
26	HEAT REJECTION SYSTEM	0	0	0	0	0	0	0	0	0	0	0
2	SUBTOTAL NUCLEAR ISLAND	75,312	674,992	810,798	655,062	669,699	125,521	367,331	758,978	46,766	81,827	4,266,287
	ENERGY CONVERSION AREA											
21	STRUCTURES & IMPROVEMENTS	0	82,177	59,357	214,670	85,103	0	60,686	36,306	2,492	8,776	549,567
22	REACTOR PLANT EQUIPMENT	999	0	0	666	0	1,665	1,551	6,338	450	0	11,669
23	TURBINE PLANT EQUIPMENT	48,162	33,353	110,305	48,352	25,134	80,269	111,515	471,927	32,161	3,876	965,054
24	ELECTRIC PLANT EQUIPMENT	144	27	124,457	500	692	240	4,216	50,524	110	0	180,909
25	MISCELLANEOUS PLANT EQUIPMENT	7,965	1,267	30,760	6,309	4,193	13,274	51,128	253,601	15,782	155	384,434
26	HEAT REJECTION SYSTEM	18,043	26,322	60,503	33,527	35,650	30,072	39,309	114,333	7,924	3,218	368,902
2	SUBTOTAL ENERGY CONVERSION AREA	75,312	143,147	385,382	304,024	150,772	125,521	268,404	933,029	58,919	16,025	2,460,535
	TOTAL MANHOURS	150,625	818,139	1,196,180	959,087	820,471	251,042	635,735	1,692,008	105,685	97,852	6,726,822

TABLE 3-5(d)
MHTGR-SC TARGET PLANT CRAFT MANHOURS BY AREA

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	BOILERMAKER	CARPENTER	ELECTRICIAN	IRONWORKER	LABORER	MILLWRIGHT	OPERATING ENGINEER	PIPE FITTER	TEAMSTER	OTHER	TOTALS
	NUCLEAR ISLAND											
21	STRUCTURES & IMPROVEMENTS	6,995	643,975	147,753	514,410	639,780	11,658	219,475	87,982	14,981	78,878	2,365,884
22	REACTOR PLANT EQUIPMENT	30,628	6,333	121,346	92,440	5,614	51,046	83,781	320,171	20,336	15	731,711
23	TURBINE PLANT EQUIPMENT	0	104	4,971	0	52	0	52	0	0	0	5,178
24	ELECTRIC PLANT EQUIPMENT	0	0	493,953	0	0	0	14,113	197,581	0	0	705,647
25	MISCELLANEOUS PLANT EQUIPMENT	34,989	378	13,704	24,720	236	58,316	36,736	126,032	9,772	0	304,883
26	HEAT REJECTION SYSTEM	0	0	0	0	0	0	0	0	0	0	0
2	SUBTOTAL NUCLEAR ISLAND	72,612	650,789	781,727	631,570	645,682	121,020	354,157	731,765	45,089	78,893	4,113,303
	ENERGY CONVERSION AREA											
21	STRUCTURES & IMPROVEMENTS	0	79,232	57,229	206,973	82,052	0	58,509	35,002	2,402	8,461	529,860
22	REACTOR PLANT EQUIPMENT	963	0	0	642	0	1,605	1,495	6,111	434	0	11,250
23	TURBINE PLANT EQUIPMENT	46,436	32,157	106,350	46,619	24,233	77,393	107,518	455,010	31,008	3,737	930,459
24	ELECTRIC PLANT EQUIPMENT	139	26	119,988	483	667	232	4,065	48,710	106	0	174,415
25	MISCELLANEOUS PLANT EQUIPMENT	7,679	1,222	29,658	6,083	4,041	12,798	49,293	244,504	15,216	150	370,643
26	HEAT REJECTION SYSTEM	17,396	25,378	58,333	32,323	34,373	28,994	37,899	110,232	7,640	3,103	355,672
2	SUBTOTAL ENERGY CONVERSION AREA	72,613	138,015	371,557	293,122	145,367	121,021	258,779	899,569	56,806	15,451	2,372,299
	TOTAL MANHOURS	145,224	788,804	1,153,283	924,692	791,049	242,041	612,936	1,631,334	101,895	94,344	6,485,602

TABLE 3-6(a)
MHTGR-SC LEAD MODULE CRAFT MANHOURS BY ACCOUNT

CRAFT	ACCOUNT 21	ACCOUNT 22	ACCOUNT 23	ACCOUNT 24	ACCOUNT 25	ACCOUNT 26	TOTAL MANHOURS	% OF TOTAL
BOILERMAKER	3,297	17,131	16,025	147	41,161	8,573	86,335	2.6%
CARPENTER	367,286	2,420	10,585	28	1,637	15,950	397,906	11.8%
ELECTRICIAN	107,313	49,346	39,533	206,448	38,651	36,869	478,159	14.1%
IRONWORKER	409,924	36,438	15,898	511	29,697	17,460	509,927	15.1%
LABORER	394,553	2,094	7,956	706	4,490	21,635	431,434	12.8%
MILLWRIGHT	5,496	28,552	26,709	245	68,602	14,288	143,891	4.3%
OPERATING ENGINEER	165,379	39,418	36,426	6,572	83,030	21,896	352,721	10.4%
PIPEFITTER	61,920	153,409	153,559	83,336	356,175	64,825	873,223	25.8%
TEAMSTER	10,968	10,039	10,484	112	24,113	4,395	60,110	1.8%
OTHER	43,979	16	1,217	0	158	1,961	47,332	1.4%
TOTAL CRAFT MANHOURS	1,570,114	338,862	318,391	298,103	647,715	207,852	3,381,037	100.0%
% OF TOTAL	46.4%	10.0%	9.4%	8.8%	19.2%	6.1%	100.0%	N/A

TABLE 3-6(b)
MHTGR-SC PROTOTYPE PLANT CRAFT MANHOURS BY ACCOUNT

CRAFT	ACCOUNT 21	ACCOUNT 22	ACCOUNT 23	ACCOUNT 24	ACCOUNT 25	ACCOUNT 26	TOTAL MANHOURS	% OF TOTAL
BOILERMAKER	7,750	34,958	51,963	147	45,497	19,494	159,809	2.2%
CARPENTER	799,896	7,065	36,144	28	1,699	28,440	873,271	12.2%
ELECTRICIAN	226,369	135,166	124,438	687,270	46,505	65,369	1,285,116	17.9%
IRONWORKER	794,268	103,861	52,183	511	32,847	36,224	1,019,894	14.2%
LABORER	795,952	6,268	27,209	706	4,530	38,518	873,183	12.2%
MILLWRIGHT	12,917	58,264	86,606	245	75,828	32,491	266,349	3.7%
OPERATING ENGINEER	305,382	94,680	120,423	20,310	91,732	42,446	674,974	9.4%
PIPEFITTER	135,995	361,965	509,416	275,665	395,223	123,400	1,801,663	25.1%
TEAMSTER	19,037	23,025	34,715	112	26,645	8,554	112,087	1.6%
OTHER	96,632	16	4,187	0	158	3,477	104,471	1.5%
TOTAL CRAFT MANHOURS	3,194,196	825,269	1,047,284	984,992	720,663	398,412	7,170,816	100.0%
% OF TOTAL	44.5%	11.5%	14.6%	13.7%	10.0%	5.6%	100.0%	N/A

TABLE 3–6(c)
MHTGR–SC REPLICA PLANT CRAFT MANHOURS BY ACCOUNT

CRAFT	ACCOUNT 21	ACCOUNT 22	ACCOUNT 23	ACCOUNT 24	ACCOUNT 25	ACCOUNT 26	TOTAL MANHOURS	% OF TOTAL
BOILERMAKER	7,255	32,766	48,162	144	44,255	18,043	150,625	2.2%
CARPENTER	750,100	6,569	33,461	27	1,660	26,322	818,139	12.2%
ELECTRICIAN	212,601	125,857	115,460	636,784	44,975	60,503	1,196,180	17.8%
IRONWORKER	748,214	96,544	48,352	500	31,949	33,527	959,087	14.3%
LABORER	748,680	5,824	25,188	692	4,437	35,650	820,471	12.2%
MILLWRIGHT	12,092	54,610	80,269	240	73,759	30,072	251,042	3.7%
OPERATING ENGINEER	288,326	88,448	111,569	18,854	89,229	39,309	635,735	9.5%
PIPEFITTER	127,559	338,417	471,927	255,455	384,316	114,333	1,692,008	25.2%
TEAMSTER	18,030	21,543	32,161	110	25,918	7,924	105,685	1.6%
OTHER	90,587	16	3,876	0	155	3,218	97,852	1.5%
TOTAL CRAFT MANHOURS	3,003,443	770,595	970,424	912,805	700,653	368,902	6,726,822	100.0%
% OF TOTAL	44.6%	11.5%	14.4%	13.6%	10.4%	5.5%	100.0%	N/A

TABLE 3–6(d)
MHTGR–SC TARGET PLANT CRAFT MANHOURS BY ACCOUNT

CRAFT	ACCOUNT 21	ACCOUNT 22	ACCOUNT 23	ACCOUNT 24	ACCOUNT 25	ACCOUNT 26	TOTAL MANHOURS	% OF TOTAL
BOILERMAKER	6,995	31,591	46,436	139	42,668	17,396	145,224	2.2%
CARPENTER	723,206	6,333	32,260	26	1,600	25,378	788,804	12.2%
ELECTRICIAN	204,981	121,346	111,321	613,941	43,362	58,333	1,153,283	17.8%
IRONWORKER	721,383	93,082	46,619	483	30,802	32,323	924,692	14.3%
LABORER	721,832	5,614	24,284	667	4,277	34,373	791,049	12.2%
MILLWRIGHT	11,658	52,652	77,393	232	71,114	28,994	242,041	3.7%
OPERATING ENGINEER	277,984	85,276	107,570	18,178	86,029	37,899	612,936	9.5%
PIPEFITTER	122,983	326,281	455,010	246,292	370,535	110,232	1,631,334	25.2%
TEAMSTER	17,383	20,770	31,008	106	24,988	7,640	101,895	1.6%
OTHER	87,339	15	3,737	0	150	3,103	94,344	1.5%
TOTAL CRAFT MANHOURS	2,895,744	742,961	935,637	880,062	675,526	355,672	6,485,602	100.0%
% OF TOTAL	44.6%	11.5%	14.4%	13.6%	10.4%	5.5%	100.0%	N/A
% CHANGE, FROM PROTOTYPE	−9.3%	−10.0%	−10.7%	−10.7%	−6.3%	−10.7%	−9.6%	N/A

TABLE 3–7
MHTGR–SC REACTOR PLANT EQUIPMENT COSTS

ACCOUNT NUMBER	REACTOR PLANT EQUIPMENT	LEARNING FACTOR	FOAK COSTS	LEAD MODULE	LEAD MODULE W/FOAK	PROTOTYPE PLANT	PROTOTYPE W/FOAK	REPLICA PLANT	TARGET PLANT
			EQUIPMENT						
221	REACTOR SYSTEM								
221.3111 .	NEUTRON CONTROL	94.0%	1,400,000	3,799,000	5,199,000	14,170,974	15,570,974	12,876,677	11,342,729
221.31121.	GRAPHITE REACTOR INTERNALS	94.0%	4,263,000	8,713,000	12,976,000	32,501,104	36,764,104	29,532,637	26,014,530
221.31122	METALLIC REACTOR INTERNALS	94.0%	300,000	17,400,000	17,700,000	64,905,224	65,205,224	58,977,148	51,951,430
221.3113 .	REACTOR CORE (W/O FUEL)	94.0%	1,850,000	3,830,000	5,680,000	14,286,610	16,136,610	12,981,752	11,435,286
221.1114 .	REACTOR SERVICE EQUIPMENT	94.0%	701,000	9,792,000	10,493,000	9,792,000	10,493,000	9,204,480	8,230,605
222	VESSEL SYSTEM								
222.31211.	REACTOR VESSEL & CROSS VESSEL	98.0%	2,350,000	17,390,000	19,740,000	67,975,540	70,325,540	65,896,713	63,224,990
222.31212.	STEAM GENERATOR PRESSURE VESSEL	98.0%	2,000,000	9,570,000	11,570,000	37,408,046	39,408,046	36,264,033	34,793,741
222.3122 .	REACTOR PRESSURE RELIEF	94.0%	320,000	1,010,000	1,330,000	3,767,487	4,087,487	3,423,386	3,015,572
222.3123 .	VESSEL SUPPORTS	94.0%	0	3,800,000	3,800,000	14,174,704	14,174,704	12,880,067	11,345,715
223	HEAT TRANSPORT SYSTEM								
223.31310.	MAIN HELIUM CIRCULATOR	94.0%	1,229,000	7,030,000	8,259,000	26,223,202	27,452,202	23,828,124	20,989,572
223.31320.	STEAM GENERATOR	96.0%	3,670,000	16,500,000	20,170,000	63,012,632	66,682,632	59,166,994	54,418,664
223.31330.	HEAT TRANSPORT SYSTEM INTERNALS	94.0%	1,800,000	4,100,000	5,900,000	15,293,760	17,093,760	13,896,914	12,241,429
223.11340.	HTS SERVICE SYSTEM EQUIPMENT	94.0%	175,000	2,453,000	2,628,000	2,453,000	2,628,000	2,305,820	2,061,854
224	SHUTDOWN COOLING SYSTEM								
224.31410.	SHUTDOWN CIRCULATOR	94.0%	194,000	1,166,000	1,360,000	4,349,396	4,543,396	3,952,147	3,481,343
224.31420.	SHUTDOWN COOLING HEAT EXCHANGER	96.0%	920,000	2,170,000	3,090,000	8,287,116	9,207,116	7,781,356	7,156,879
224.31430.	SHUTDOWN COOLING SYSTEM CONTROLS	94.0%	168,000	416,000	584,000	1,551,757	1,719,757	1,410,028	1,242,057
224.11440.	SCS SERVICE EQUIPMENT	94.0%	175,000	392,000	567,000	392,000	567,000	368,480	329,493
227	REACTOR SERVICE SYSTEM								
227.12110.0	CORE REFUELING	94.0%	1,974,000	13,734,000	15,708,000	13,734,000	15,708,000	12,909,960	11,544,029
227.52110.2	CORE REFUELING	94.0%	0	7,336,000	7,336,000	14,231,840	14,231,840	13,132,799	11,630,983
227.12120.	SITE FUEL HANDLING	94.0%	158,000	2,860,000	3,018,000	2,860,000	3,018,000	2,688,400	2,403,955
227.32410.0	HELIUM PURIFICATION	94.0%	125,000	644,000	769,000	2,402,239	2,527,239	2,182,832	1,922,800
227.52410.2	HELIUM PURIFICATION	94.0%	0	229,000	229,000	444,260	444,260	409,952	363,072
228	PLANT CONTROL, PROTECTION, & MONITORING								
228.33100.0	REACTOR PROTECTION SYSTEM	94.0%	53,000	364,000	417,000	1,357,787	1,410,787	1,233,775	1,086,800
228.33300.0	INVESTMENT PROTECTION & INSTR	94.0%	105,000	469,000	574,000	1,749,457	1,854,457	1,589,671	1,400,300
228.33400.0	PLANT CONTROL SYSTEM	94.0%	108,000	483,000	591,000	1,801,679	1,909,679	1,637,124	1,442,100
228.53400.2	PLANT CONTROL SYSTEM	94.0%	0	1,397,000	1,397,000	2,710,180	2,710,180	2,500,889	2,214,897
228.33540.0	NI ANALYTICAL INSTRUMENTATION	94.0%	54,000	137,000	191,000	511,035	565,035	464,360	409,043
229	REACTOR PLANT MISCELLANEOUS ITEMS								
229.1001	REACTOR PLANT MISC. ITEMS	94.0%	0	5,000,000	5,000,000	5,000,000	5,000,000	4,700,000	4,202,719
229.10011.	CHECKOUT & STARTUP TEST EQUIPMENT	94.0%	1,311,000	2,479,000	3,790,000	2,479,000	3,790,000	2,330,260	2,083,708
229.10012.	MAINTENANCE MONITORING & ISI EQUIP	94.0%	261,000	1,491,000	1,752,000	1,491,000	1,752,000	1,401,540	1,253,251
229.30030.	TRANSPORTATION OF MAJOR EQUIPMENT	100.0%	610,000	440,000	1,050,000	1,760,000	2,370,000	1,760,000	1,760,000
	TOTAL DIRECT COST		26,274,000	146,594,000	172,868,000	433,077,031	459,351,031	403,688,320	366,993,545

TABLE 3–8
MHTGR–SC LEAD MODULE BULK COMMODITIES

ACCOUNT NUMBER	FORMWORK (SF)	STRUCTURAL STEEL (TN)	REINFORCING STEEL (TN)	EMBEDDED STEEL (TN)	STRUCTURAL CONCRETE (CY)	CONCRETE FILL (CY)	CS PIPE <2.5" (LF)	CS PIPE >2" (LF)	SS PIPE <2.5" (LF)	SS PIPE >2" (LF)	CM PIPE >2" (LF)	POWER CABLE (LF)	CONTROL CABLE (LF)	CABLE TRAY (LF)
NI														
21	493,350	2,147	8,953	187	52,029		30	400						
22	260		5	0	35		9,000	7,250	450	500			90,000	
23														
24												474,750	124,000	10,500
25														
26														
SUBTOTAL NI	493,610	2,147	8,958	187	52,064	0	9,030	7,650	450	500	0	474,750	214,000	10,500
ECA														
21	54,345	1,155	800	27	11,500									
22									2,000	150				
23	17,475		222	11	2,905		2,745	6,113			1,172			
24												91,250	397,500	5,625
25	4,120		36	4	567		1,050	100	2,125	1,250				
26	19,468	2	1,076	4	4,883		650	13,800						
SUBTOTAL ECA	95,408	1,157	2,134	46	19,855	0	4,445	20,013	4,125	1,400	1,172	91,250	397,500	5,625
TOTAL PLANT														
21	547,695	3,302	9,753	214	63,529	0	30	400	0	0	0	0	0	0
22	260	0	5	0	35	0	9,000	7,250	2,450	650	0	0	90,000	0
23	17,475	0	222	11	2,905	0	2,745	6,113	0	0	1,172	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	566,000	521,500	16,125
25	4,120	0	36	4	567	0	1,050	100	2,125	1,250	0	0	0	0
26	19,468	2	1,076	4	4,883	0	650	13,800	0	0	0	0	0	0
TOTAL PLANT	589,018	3,304	11,092	233	71,919	0	13,475	27,663	4,575	1,900	1,172	566,000	611,500	16,125
UNITS	SF/MWe	TN/MWe	TN/MWe	TN/MWe	CY/MWe	CY/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe
NI	2,850	12	52	1	301	0	52	44	3	3	0	2,741	1,236	61
ECA	551	7	12	0	115	0	26	116	24	8	7	527	2,295	32
TOTAL PLANT	3,401	19	64	1	415	0	78	160	26	11	7	3,268	3,531	93

TABLE 3–9
MHTGR–SC PLANT BULK COMMODITIES

ACCOUNT NUMBER	FORMWORK (SF)	STRUCTURAL STEEL (TN)	REINFORCING STEEL (TN)	EMBEDDED STEEL (TN)	STRUCTURAL CONCRETE (CY)	CONCRETE FILL (CY)	CS PIPE <2.5" (LF)	CS PIPE >2" (LF)	SS PIPE <2.5" (LF)	SS PIPE >2" (LF)	CM PIPE >2" (LF)	POWER CABLE (LF)	CONTROL CABLE (LF)	CABLE TRAY (LF)
NI														
21	1,241,160	3,686	24,873	515	120,205		120	1,600						
22	260		5	0	35		16,150	18,700	1,800	2,000			90,000	
23														
24												1,899,000	496,000	42,000
25														
26														
SUBTOTAL NI	1,241,420	3,686	24,878	515	120,240	0	16,270	20,300	1,800	2,000	0	1,899,000	586,000	42,000
ECA														
21	179,754	4,059	1,748	34	24,205									
22									2,000	150				
23	68,310		882	42	11,580		9,360	19,582			4,688			
24												365,000	1,590,000	22,500
25	4,120		36	4	567		4,050	100	5,500	1,250				
26	38,936	4	2,152	8	9,766		2,600	37,800						
SUBTOTAL ECA	291,120	4,063	4,818	88	46,118	0	16,010	57,482	7,500	1,400	4,688	365,000	1,590,000	22,500
TOTAL PLANT														
21	1,420,914	7,745	26,621	549	144,410	0	120	1,600	0	0	0	0	0	0
22	260	0	5	0	35	0	16,150	18,700	3,800	2,150	0	0	90,000	0
23	68,310	0	882	42	11,580	0	9,360	19,582	0	0	4,688	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	2,264,000	2,086,000	64,500
25	4,120	0	36	4	567	0	4,050	100	5,500	1,250	0	0	0	0
26	38,936	4	2,152	8	9,766	0	2,600	37,800	0	0	0	0	0	0
TOTAL PLANT	1,532,540	7,749	29,696	603	166,358	0	32,280	77,782	9,300	3,400	4,688	2,264,000	2,176,000	64,500
UNITS	SF/MWe	TN/MWe	TN/MWe	TN/MWe	CY/MWe	CY/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe
NI	1,792	5	36	1	174	0	23	29	3	3	0	2,741	846	61
ECA	420	6	7	0	67	0	23	83	11	2	7	527	2,295	32
TOTAL PLANT	2,212	11	43	1	240	0	47	112	13	5	7	3,268	3,141	93

TABLE 3–10
MHTGR–SC OWNER'S COST ESTIMATE

OWNER'S COST ACCOUNT	LEAD MODULE	PROTOTYPE PLANT	REPLICA PLANT	TARGET PLANT
941.1 ENGINEERING/SITE MANAGEMENT	2,604,960	4,522,500	1,772,820	1,447,200
941.2 QUALITY ASSURANCE	2,147,985	3,632,108	1,496,340	1,363,568
941.3 PROJECT LICENSING	4,555,899	6,249,812	2,687,715	2,051,325
941.4 PROJECT MANAGEMENT & CONTROL	4,817,325	7,564,983	3,715,775	3,055,075
941 PROJECT MANAGEMENT	14,126,169	21,969,402	9,672,650	7,917,168
942.1 PROPERTY TAXES	0	32,000,000	48,000,000	43,000,000
942.2 LICENSING FEES & PERMITS	9,725,000	15,950,000	5,350,000	5,350,000
942.3 INSURANCE	0	4,200,000	4,200,000	2,410,000
942 FEES, TAXES, & INSURANCE	9,725,000	52,150,000	57,550,000	50,760,000
943.1 INITIAL SPARE PARTS INVENTORY	8,300,000	15,200,000	14,600,000	13,800,000
943.2 CONSUMABLES, SUPPLIES, & COOLANTS	557,246	1,605,610	1,612,018	1,632,019
943.3 PLANT EQUIPMENT & FURNISHINGS	10,600,000	14,900,000	14,900,000	14,900,000
943 SPARE PARTS AND CAPITAL EQUIPMENT	19,457,246	31,705,610	31,112,018	30,332,019
944.1 SITE STAFF TRAINING & STARTUP	32,766,683	49,835,646	45,321,651	27,832,809
944.2 MAINTENANCE MATERIALS	907,500	2,015,833	1,507,500	1,172,500
944.3 SUPPLIES & EXPENSES	2,450,769	5,297,035	5,210,574	3,370,125
944 STAFF TRAINING AND STARTUP	36,124,952	57,148,514	52,039,725	32,375,433
945 GENERAL AND ADMINISTRATIVE	10,456,255	16,623,529	13,923,659	10,593,693
TOTAL OWNERS COSTS	89,889,622	179,597,055	164,298,051	131,978,313

TABLE 3–11
MHTGR–SC TARGET PLANT COST BY ESTIMATOR

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	COST ESTIMATOR					TOTAL COST	% OF TOTAL
		BNI	SWEC	GA	ABB–CE	GCRA		
20	LAND & LAND RIGHTS	0	0	0	0	2,000,000	2,000,000	0.16%
211	YARDWORK	3,735,261	3,310,430	0	0	0	7,045,691	0.58%
212.1	REACTOR BUILDING	95,882,094	0	0	0	0	95,882,094	7.87%
212.2	REACTOR AUXILIARY BUILDING	0	0	0	0	0	0	0.00%
212.3	REACTOR SERVICE BUILDING	1,432,154	0	0	0	0	1,432,154	0.12%
212.4	PERSONNEL SERVICE BUILDING	10,968,929	0	0	0	0	10,968,929	0.90%
212.5	RADWASTE BUILDING	3,450,491	0	0	0	0	3,450,491	0.28%
212	REACTOR COMPLEX	111,733,668	0	0	0	0	111,733,668	9.17%
213	TURBINE COMPLEX	0	23,461,555	0	0	0	23,461,555	1.93%
214	OPERATIONS CENTER	0	4,346,034	0	0	0	4,346,034	0.36%
215	REMOTE SHUTDOWN BUILDING	145,033	0	0	0	0	145,033	0.01%
216	OTHER BUILDINGS	1,536,198	1,800,729	0	0	0	3,336,927	0.27%
21	STRUCTURES & IMPROVEMENTS	117,150,160	32,918,748	0	0	0	150,068,908	12.32%
221	REACTOR SYSTEM	1,670,994	0	57,023,149	51,951,430	0	110,645,574	9.08%
222	VESSEL SYSTEM	8,422,062	0	0	112,380,017	0	120,802,079	9.91%
223	HEAT TRANSPORT SYSTEM	501,944	0	23,051,426	66,660,093	0	90,213,463	7.40%
224	SHUTDOWN COOLING SYSTEM	689,241	0	5,052,893	7,156,879	0	12,899,013	1.06%
225	SHUTDOWN COOLING WATER SYSTEM	3,671,601	0	0	0	0	3,671,601	0.30%
226	REACTOR CAVITY COOLING SYSTEM	14,330,012	0	0	0	0	14,330,012	1.18%
227	REACTOR SERVICE SYSTEM	18,984,794	1,023,335	27,864,839	0	0	47,872,968	3.93%
228	REACTOR CONTROL, PROTECTION & MONITORING	5,933,998	273,496	6,553,140	0	0	12,760,634	1.05%
229	REACTOR PLANT MISCELLANEOUS	731,595	0	3,336,959	5,962,719	0	10,031,273	0.82%
22	REACTOR PLANT EQUIPMENT	54,936,241	1,296,831	122,882,406	244,111,138	0	423,226,617	34.74%
231	TURBINE GENERATOR & AUXILIARIES	0	78,902,241	0	0	0	78,902,241	6.48%
233	MAIN & AUXILIARY STEAM SYSTEM	0	14,425,720	0	0	0	14,425,720	1.18%
234	FEEDWATER & CONDENSATE SYSTEM	0	33,723,708	0	0	0	33,723,708	2.77%
235	STARTUP & SHUTDOWN SYSTEM	0	0	0	0	0	0	0.00%
236	TURBINE PLANT SAMPLING SYSTEM	0	2,621,910	0	0	0	2,621,910	0.22%
237	ECA CONTROL, DATA & INSTRUMENTATION	181,787	25,807,882	0	0	0	25,989,669	2.13%
23	TURBINE PLANT EQUIPMENT	181,787	155,481,461	0	0	0	155,663,248	12.78%
241	SWITCHGEAR	330,327	6,924,200	0	0	0	7,254,527	0.60%
242	STATION SERVICE EQUIPMENT	7,072,162	6,760,962	0	0	0	13,833,124	1.14%
243	SWITCHBOARDS	20,051	4,074,034	0	0	0	4,094,085	0.34%
244	PROTECTIVE EQUIPMENT	0	473,829	0	0	0	473,829	0.04%
245	ELECTRIC STRUCTURES & WIRING CONTAINERS	10,791,508	2,192,075	0	0	0	12,983,583	1.07%
246	POWER AND CONTROL WIRING	6,936,284	6,353,534	0	0	0	13,289,818	1.09%
24	ELECTRIC PLANT EQUIPMENT	25,150,332	26,778,634	0	0	0	51,928,966	4.26%
251	TRANSPORTATION AND LIFT EQUIPMENT	1,741,254	869,738	0	0	0	2,610,992	0.21%
252	AIR, WATER, AND STEAM SERVICE SYSTEM	11,004,779	20,089,154	0	0	0	31,093,933	2.55%
253	COMMUNICATIONS AND SECURITY EQUIPMENT	2,379,344	2,181,988	0	0	0	4,561,332	0.37%
254	FURNISHINGS AND FIXTURES	1,360,421	539,830	0	0	0	1,900,251	0.16%
25	MISCELLANEOUS PLANT EQUIPMENT	16,485,798	23,680,710	0	0	0	40,166,508	3.30%
261	CIRCULATING AND SERVICE WATER PUMPHOUSE	0	476,796	0	0	0	476,796	0.04%
262	ECA COOLING WATER SYSTEMS	0	3,548,103	0	0	0	3,548,103	0.29%
263	CIRCULATING AND SERVICE WATER SYSTEM	0	26,148,069	0	0	0	26,148,069	2.15%
26	HEAT REJECTION SYSTEM	0	30,172,968	0	0	0	30,172,968	2.48%
2	TOTAL DIRECT COSTS	213,904,318	270,329,352	122,882,406	244,111,138	2,000,000	853,227,215	70.03%
911	TEMPORARY CONSTRUCTION FACILITIES	36,946,746	7,380,000	0	0	0	44,326,746	3.64%
912	CONSTRUCTION TOOLS AND EQUIPMENT	18,866,423	9,700,000	0	0	0	28,566,423	2.34%
913	PAYROLL INSURANCE AND TAXES	22,010,827	20,000,000	0	0	0	42,010,827	3.45%
914	PERMITS, INSURANCE, AND LOCAL TAXES	786,101	960,000	0	0	0	1,746,101	0.14%
91	CONSTRUCTION SERVICES	78,610,098	38,040,000	0	0	0	116,650,098	9.57%
920	REACTOR MODULE ENGINEERING AND SERVICES	0	0	17,117,918	0	0	17,117,918	1.40%
921	PLANT ENGINEERING AND SERVICES	28,963,190	2,600,000	0	0	0	31,563,190	2.59%
922	HOME OFFICE QUALITY ASSURANCE	965,440	0	0	0	0	965,440	0.08%
923	HOME OFFICE PROJECT & CONSTRUCTION MGMT.	8,688,957	1,370,000	0	0	0	10,058,957	0.83%
92	ENGINEERING AND HOME OFFICE SERVICES	38,617,587	3,970,000	17,117,918	0	0	59,705,505	4.90%
931	FIELD OFFICE EXPENSES	5,099,084	900,000	0	0	0	5,999,084	0.49%
932	FIELD JOB SUPERVISION	20,032,115	19,300,000	0	0	0	39,332,115	3.23%
933	FIELD QUALITY ASSURANCE/QUALITY CONTROL	1,821,101	0	0	0	0	1,821,101	0.15%
934	PLANT STARTUP AND TEST	9,469,727	225,000	0	0	0	9,694,727	0.80%
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	36,422,027	20,425,000	0	0	0	56,847,027	4.67%
941	PROJECT MANAGEMENT EXPENSES	0	0	0	0	7,917,168	7,917,168	0.65%
942	FEES, TAXES, AND INSURANCE	0	0	0	0	50,760,000	50,760,000	4.17%
943	SPARE PARTS AND CAPITAL EQUIPMENT	0	0	0	0	30,332,019	30,332,019	2.49%
944	STAFF TRAINING AND STARTUP	0	0	0	0	32,375,433	32,375,433	2.66%
945	GENERAL & ADMINISTRATIVE	0	0	0	0	10,593,693	10,593,693	0.87%
94	OWNER'S COSTS	0	0	0	0	131,978,313	131,978,313	10.83%
9	TOTAL INDIRECT COSTS	153,649,711	62,435,000	17,117,918	0	131,978,313	365,180,942	29.97%
	TOTAL BASE CONSTRUCTION COST	367,554,029	332,764,352	140,000,324	244,111,138	133,978,313	1,218,408,156	100.00%
		30.17%	27.31%	11.49%	20.04%	11.00%	100.00%	

TABLE 3–12
MHTGR–SC PLANT CONTINGENCIES BY ACCOUNT

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	LEAD MODULE		PROTOTYPE		REPLICA		TARGET	
		1992$	%	1992$	%	1992$	%	1992$	%
20	LAND & LAND RIGHTS	300,000	15.0%	300,000	15.0%	300,000	15.0%	300,000	15.0%
211	YARDWORK	1,326,495	18.2%	1,326,495	18.2%	1,309,986	18.2%	1,280,972	18.2%
212	REACTOR COMPLEX	9,921,384	19.9%	24,258,148	20.6%	23,458,480	20.6%	23,046,057	20.6%
213	TURBINE COMPLEX	1,367,846	15.0%	3,666,085	15.0%	3,568,866	15.0%	3,519,244	15.0%
214	OPERATIONS CENTER	667,270	15.0%	667,270	15.0%	661,703	15.0%	651,904	15.0%
215	REMOTE SHUTDOWN BUILDING	28,494	19.0%	28,494	19.0%	28,157	19.0%	27,558	19.0%
216	OTHER BUILDINGS	514,646	15.0%	514,646	15.0%	509,557	15.0%	500,537	15.0%
21	STRUCTURES & IMPROVEMENTS	13,826,135	18.6%	30,461,138	19.4%	29,536,749	19.3%	29,026,272	19.3%
221	REACTOR SYSTEM	13,149,373	25.0%	36,492,542	25.0%	31,310,347	25.0%	27,645,858	25.0%
222	VESSEL SYSTEM	6,044,754	15.5%	21,271,091	15.5%	19,737,598	15.5%	18,794,081	15.6%
223	HEAT TRANSPORT SYSTEM	8,283,903	22.3%	25,280,806	22.1%	21,981,592	22.0%	19,842,473	22.0%
224	SHUTDOWN COOLING SYSTEM	1,311,840	22.4%	3,755,572	22.4%	3,181,535	22.4%	2,880,694	22.3%
225	SHUTDOWN COOLING WATER SYSTEM	210,202	18.0%	775,182	18.0%	717,596	18.0%	660,887	18.0%
226	REACTOR CAVITY COOLING SYSTEM	941,006	19.0%	3,258,460	19.0%	2,947,983	19.0%	2,722,703	19.0%
227	REACTOR SERVICE SYSTEM	9,739,505	22.6%	13,211,748	22.7%	11,867,937	22.6%	10,767,233	22.5%
228	REACTOR CONTROL, PROTECTION & MONITORING	1,454,200	23.9%	3,689,257	24.2%	3,349,268	24.1%	3,072,410	24.1%
229	REACTOR PLANT MISCELLANEOUS	4,244,177	34.4%	4,442,177	32.5%	3,746,803	34.3%	3,397,130	33.9%
22	REACTOR PLANT EQUIPMENT	45,378,962	22.5%	112,176,835	21.5%	98,840,659	21.3%	89,783,468	21.2%
231	TURBINE GENERATOR & AUXILIARIES	4,080,242	15.0%	12,976,436	15.0%	11,874,120	15.0%	11,833,148	15.0%
233	MAIN & AUXILIARY STEAM SYSTEM	603,756	15.0%	2,230,123	15.0%	2,184,303	15.0%	2,163,856	15.0%
234	FEEDWATER & CONDENSATE SYSTEM	1,529,988	15.0%	5,215,458	15.0%	5,107,307	15.0%	5,058,559	15.0%
235	STARTUP & SHUTDOWN SYSTEM	0	0.0%	0	0.0%	0	0.0%	0	0.0%
236	TURBINE PLANT SAMPLING SYSTEM	102,938	15.0%	400,992	15.0%	395,665	15.0%	393,287	15.0%
237	ECA CONTROL, DATA & INSTRUMENTATION	1,050,998	15.3%	3,975,769	15.1%	3,938,089	15.1%	3,920,265	15.1%
23	TURBINE PLANT EQUIPMENT	7,367,922	15.0%	24,798,778	15.0%	23,499,484	15.0%	23,369,115	15.0%
241	SWITCHGEAR	318,031	15.6%	1,148,715	15.6%	1,134,292	15.6%	1,127,820	15.5%
242	STATION SERVICE EQUIPMENT	1,001,823	19.2%	2,961,935	21.2%	2,936,154	21.1%	2,923,628	21.1%
243	SWITCHBOARDS	155,440	15.1%	618,705	15.1%	617,204	15.1%	616,519	15.1%
244	PROTECTIVE EQUIPMENT	67,223	15.0%	73,626	15.0%	72,655	15.0%	71,073	15.0%
245	ELECTRIC STRUCTURES & WIRING CONTAINERS	1,034,189	25.1%	3,615,696	25.1%	3,357,587	25.0%	3,242,518	25.0%
246	POWER AND CONTROL WIRING	863,562	21.8%	3,088,069	21.5%	2,906,701	21.3%	2,825,826	21.3%
24	ELECTRIC PLANT EQUIPMENT	3,440,268	20.5%	11,506,746	21.0%	11,024,593	20.9%	10,807,384	20.8%

TABLE 3–12
MHTGR–SC PLANT CONTINGENCIES BY ACCOUNT

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	LEAD MODULE		PROTOTYPE		REPLICA		TARGET	
		1992$	%	1992$	%	1992$	%	1992$	%
251	TRANSPORTATION AND LIFT EQUIPMENT	301,888	16.2%	431,388	16.3%	428,614	16.3%	426,475	16.3%
252	AIR, WATER, AND STEAM SERVICE SYSTEM	4,453,243	16.2%	5,174,093	16.1%	5,102,188	16.1%	5,007,585	16.1%
253	COMMUNICATIONS AND SECURITY EQUIPMENT	940,436	21.6%	985,634	21.1%	977,881	21.2%	968,763	21.2%
254	FURNISHINGS AND FIXTURES	477,057	25.0%	477,057	25.0%	476,495	25.0%	475,497	25.0%
25	MISCELLANEOUS PLANT EQUIPMENT	6,172,624	17.3%	7,068,172	17.1%	6,985,178	17.1%	6,878,320	17.1%
261	CIRCULATING AND SERVICE WATER PUMPHOUSE	41,200	15.0%	76,491	15.0%	73,053	15.0%	71,520	15.0%
262	ECA COOLING WATER SYSTEMS	148,968	15.0%	558,773	15.0%	540,399	15.0%	532,218	15.0%
263	CIRCULATING AND SERVICE WATER SYSTEM	2,136,940	15.0%	4,051,193	15.0%	3,962,180	15.0%	3,922,215	15.0%
26	HEAT REJECTION SYSTEM	2,327,108	15.0%	4,686,457	15.0%	4,575,632	15.0%	4,525,953	15.0%
2	TOTAL DIRECT COSTS	78,813,019	19.9%	190,998,126	19.6%	174,762,295	19.4%	164,690,512	19.3%
911	TEMPORARY CONSTRUCTION FACILITIES	6,286,464	19.6%	11,348,327	20.2%	9,099,705	20.0%	8,865,817	20.0%
912	CONSTRUCTION TOOLS AND EQUIPMENT	4,099,833	18.4%	6,684,614	19.3%	5,536,381	19.0%	5,416,949	19.0%
913	PAYROLL INSURANCE AND TAXES	3,835,836	19.5%	9,101,216	18.6%	7,761,612	18.2%	7,622,274	18.1%
914	PERMITS, INSURANCE, AND LOCAL TAXES	146,201	19.1%	361,901	18.1%	314,058	17.7%	309,081	17.7%
91	CONSTRUCTION SERVICES	14,368,136	19.2%	27,496,058	19.4%	22,711,756	19.1%	22,214,121	19.0%
920	REACTOR MODULE ENGINEERING AND SERVICES	5,411,000	25.0%	13,179,831	25.0%	7,524,581	25.0%	4,279,480	25.0%
921	PLANT ENGINEERING AND SERVICES	8,962,945	11.2%	13,970,087	13.6%	7,685,715	24.2%	7,630,797	24.2%
922	HOME OFFICE QUALITY ASSURANCE	245,515	25.0%	402,670	25.0%	243,191	25.0%	241,360	25.0%
923	HOME OFFICE PROJECT & CONSTRUCTION MGMT.	3,086,008	21.0%	4,654,526	21.6%	2,394,215	23.6%	2,377,739	23.6%
92	ENGINEERING AND HOME OFFICE SERVICES	17,705,468	15.1%	32,207,113	18.2%	17,847,701	24.5%	14,529,376	24.3%
931	FIELD OFFICE EXPENSES	633,407	20.6%	1,411,557	20.2%	1,242,889	20.1%	1,205,808	20.1%
932	FIELD JOB SUPERVISION	3,079,546	19.2%	7,910,044	18.3%	7,247,423	18.1%	7,101,744	18.1%
933	FIELD QUALITY ASSURANCE/QUALITY CONTROL	214,163	21.0%	455,913	21.0%	395,675	21.0%	382,431	21.0%
934	PLANT STARTUP AND TEST	1,122,087	20.9%	2,404,498	20.9%	2,091,259	20.9%	2,022,393	20.9%
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	5,049,203	19.6%	12,182,012	19.1%	10,977,246	18.9%	10,712,376	18.8%
941	PROJECT MANAGEMENT EXPENSES	2,118,925	15.0%	3,295,410	15.0%	1,616,963	15.0%	1,187,575	15.0%
942	FEES, TAXES, AND INSURANCE	1,458,750	15.0%	7,822,500	15.0%	8,632,500	15.0%	7,614,000	15.0%
943	SPARE PARTS AND CAPITAL EQUIPMENT	2,918,587	15.0%	4,755,842	15.0%	4,666,803	15.0%	4,549,803	15.0%
944	STAFF TRAINING AND STARTUP	5,418,743	15.0%	8,572,277	15.0%	7,805,959	15.0%	4,856,315	15.0%
945	GENERAL & ADMINISTRATIVE	1,568,438	15.0%	2,493,529	15.0%	2,088,549	15.0%	1,589,054	15.0%
94	OWNER'S COSTS	13,483,443	15.0%	26,939,558	15.0%	24,810,773	15.1%	19,796,747	15.0%
9	TOTAL INDIRECT COSTS	50,606,250	16.5%	98,824,742	17.6%	76,347,476	18.4%	67,252,619	18.4%
	TOTAL BASE CONSTRUCTION COST	129,419,269	18.4%	289,822,867	18.9%	251,109,771	19.1%	231,943,131	19.0%

TABLE 3–13(a)
MHTGR–SC PROTOTYPE PLANT TOTAL CAPITAL COST COMPARISON

ACCOUNT NUMBER	ACCOUNT NAME	1992 M$ PROTOTYPE INCL. FOAK	1990 M$ CRS LEAD PLANT	% CHANGE TO 1992 ESTIMATE	1989 M$ CER LEAD PLANT	% CHANGE TO 1992 ESTIMATE
20	LAND & LAND RIGHTS	2.00	2.10	–4.8%	2.00	0.0%
21	STRUCTURES & IMPROVEMENTS	157.40	104.00	51.3%	121.20	29.9%
22	REACTOR PLANT EQUIPMENT	522.90	466.40	12.1%	366.50	42.7%
23	TURBINE PLANT EQUIPMENT	165.20	163.90	0.8%	117.00	41.2%
24	ELECTRIC PLANT EQUIPMENT	54.80	69.70	–21.4%	91.90	–40.4%
25	MISCELLANEOUS PLANT EQUIPMENT	41.30	35.70	15.7%	36.50	13.2%
26	HEAT REJECTION SYSTEM	31.20	33.90	–8.0%	27.50	13.5%
2	TOTAL DIRECT COSTS	974.80	875.70	11.3%	762.60	27.8%
91	CONSTRUCTION SERVICES	141.80	86.70	63.6%	90.10	57.4%
92	HOME OFFICE ENGINEERING	176.60	107.20	64.7%	102.00	73.1%
93	FIELD OFFICE ENGINEERING	63.80	40.40	57.9%	34.00	87.6%
94	OWNER'S COSTS	179.60	156.40	14.8%	149.70	20.0%
9	TOTAL INDIRECT COSTS	561.80	390.70	43.8%	375.80	49.5%
	BASE CONSTRUCTION COSTS	1,536.60	1,266.40	21.3%	1,138.40	35.0%
	– $/KWe –	2,218	1,830	21.2%	2,118	4.7%
	CONTINGENCY	289.80	248.00	16.9%	243.40	19.1%
	OVERNIGHT CONSTRUCTION COSTS	1,826.40	1,514.40	20.6%	1,381.80	32.2%
	– $/KWe –	2,636	2,188	20.5%	2,570	2.6%
	INTEREST DURING CONSTRUCTION	358.00	300.00	19.3%	291.70	22.7%
	TOTAL CAPITAL COST	2184.40	1814.4	20.4%	1673.5	30.5%
	– $/KWe –	3,153	2,622	20.2%	3,113	1.3%

TABLE 3–13(b)
MHTGR–SC REPLICA PLANT TOTAL CAPITAL COST COMPARISON

ACCOUNT NUMBER	ACCOUNT NAME	1992 M$ REPLICA PLANT	1990 M$ CRS REPLICA PLANT	% CHANGE TO 1992 ESTIMATE	1989 M$ CER REPLICA PLANT	% CHANGE TO 1992 ESTIMATE
20	LAND & LAND RIGHTS	2.00	2.00	0.0%	2.00	0.0%
21	STRUCTURES & IMPROVEMENTS	152.70	102.00	49.7%	118.20	29.2%
22	REACTOR PLANT EQUIPMENT	463.20	400.00	15.8%	295.90	56.5%
23	TURBINE PLANT EQUIPMENT	156.50	160.00	−2.2%	116.30	34.6%
24	ELECTRIC PLANT EQUIPMENT	52.80	68.00	−22.4%	90.30	−41.5%
25	MISCELLANEOUS PLANT EQUIPMENT	40.80	35.00	16.6%	36.10	13.0%
26	HEAT REJECTION SYSTEM	30.50	33.00	−7.6%	27.20	12.1%
2	TOTAL DIRECT COSTS	898.50	800.00	12.3%	686.00	31.0%
91	CONSTRUCTION SERVICES	119.00	83.00	43.4%	86.80	37.1%
92	HOME OFFICE ENGINEERING	73.00	81.00	−9.9%	76.60	−4.7%
93	FIELD OFFICE ENGINEERING	58.10	39.00	49.0%	32.60	78.2%
94	OWNER'S COSTS	164.30	128.00	28.4%	123.10	33.5%
9	TOTAL INDIRECT COSTS	414.40	331.00	25.2%	319.10	29.9%
	BASE CONSTRUCTION COSTS	1,312.90	1,131.00	16.1%	1,005.10	30.6%
	– $/KWe –	1,895	1,634	15.9%	1,870	1.4%
	CONTINGENCY	251.10	223.00	12.6%	213.00	17.9%
	OVERNIGHT CONSTRUCTION COSTS	1,564.00	1,354.00	15.5%	1,218.10	28.4%
	– $/KWe –	2,257	1,957	15.4%	2,266	−0.4%
	INTEREST DURING CONSTRUCTION	195.00	200.00	−2.5%	191.30	1.9%
	TOTAL CAPITAL COST	1759.00	1554	13.2%	1409.4	24.8%
	– $/KWe –	2,539	2,246	13.1%	2,622	−3.2%

TABLE 3–13(c)
MHTGR–SC TARGET PLANT TOTAL CAPITAL COST COMPARISON

ACCOUNT NUMBER	ACCOUNT NAME	1992 M$ TARGET PLANT	1990 M$ CRS TARGET PLANT	% CHANGE TO 1992 ESTIMATE	1989 M$ CER TARGET PLANT	% CHANGE TO 1992 ESTIMATE
20	LAND & LAND RIGHTS	2.00	2.00	0.0%	2.00	0.0%
21	STRUCTURES & IMPROVEMENTS	150.07	99.00	51.6%	113.10	32.7%
22	REACTOR PLANT EQUIPMENT	423.23	336.00	26.0%	244.40	73.2%
23	TURBINE PLANT EQUIPMENT	155.66	153.00	1.7%	115.00	35.4%
24	ELECTRIC PLANT EQUIPMENT	51.93	65.00	–20.1%	86.90	–40.2%
25	MISCELLANEOUS PLANT EQUIPMENT	40.17	34.00	18.1%	35.30	13.8%
26	HEAT REJECTION SYSTEM	30.17	32.00	–5.7%	26.70	13.0%
2	TOTAL DIRECT COSTS	853.23	721.00	18.3%	623.40	36.9%
91	CONSTRUCTION SERVICES	116.65	77.00	51.5%	80.00	45.8%
92	HOME OFFICE ENGINEERING	59.71	58.00	2.9%	55.00	8.6%
93	FIELD OFFICE ENGINEERING	56.85	36.00	57.9%	29.80	90.8%
94	OWNER'S COSTS	131.98	107.00	23.3%	102.10	29.3%
9	TOTAL INDIRECT COSTS	365.19	278.00	31.4%	266.90	36.8%
	BASE CONSTRUCTION COSTS	1,218.42	999.00	22.0%	890.30	36.9%
	– $/KWe –	1,759	1,444	21.8%	1,656	6.2%
	CONTINGENCY	231.90	200.00	15.9%	186.80	24.1%
	OVERNIGHT CONSTRUCTION COSTS	1,450.32	1,199.00	21.0%	1,077.10	34.7%
	– $/KWe –	2,093	1,733	20.8%	2,004	4.5%
	INTEREST DURING CONSTRUCTION	175.61	171.00	2.7%	163.00	7.7%
	TOTAL CAPITAL COST	1625.93	1370	18.7%	1240.1	31.1%
	– $/KWe –	2,347	1,980	18.5%	2,307	1.7%

TABLE 3–14
MHTGR–SC TARGET PLANT CASH FLOW

Year at Start of Quarter	2010.8	2011.0	2011.3	2011.5	2011.8	2012.0	2012.3	2012.5	2012.8	2013.0	2013.3
Month Relative to Site Work	−30	−27	−24	−21	−18	−15	−12	−9	−6	−3	3
Quarter Relative to Site Work	−10	−9	−8	−7	−6	−5	−4	−3	−2	−1	1
TOTAL PLANT COSTS (1992M$)	$7	$18	$28	$35	$40	$44	$47	$49	$52	$56	$66
REAL AFUDC	$0	$0	$1	$1	$2	$3	$3	$4	$5	$6	$7
CUM INVESTMENT (1992M$)	$7	$25	$54	$90	$132	$179	$229	$283	$340	$402	$475
PLANT IN SERVICE	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
NET BASIS FOR AFUDC	$7	$25	$54	$90	$132	$179	$229	$283	$340	$402	$475
ESCALATED PLANT COSTS	$18	$45	$70	$91	$104	$117	$127	$134	$143	$155	$187
AFUDC	$1	$2	$4	$7	$10	$13	$17	$22	$26	$31	$38
CUM INVESTMENT	$18	$65	$139	$237	$351	$481	$625	$781	$951	$1,137	$1,362
PLANT IN SERVICE	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
NET BASIS FOR AFUDC	$18	$65	$139	$237	$351	$481	$625	$781	$951	$1,137	$1,362

Year at Start of Quarter	2013.5	2013.8	2014.0	2014.3	2014.5	2014.8	2015.0	2015.3	2015.5	2015.8	
Month Relative to Site Work	6	9	12	15	18	21	24	27	30	33	
Quarter Relative to Site Work	2	3	4	5	6	7	8	9	10	11	TOTAL
TOTAL PLANT COSTS (1992M$)	$78	$92	$109	$127	$140	$145	$129	$96	$57	$35	$1,450
REAL AFUDC	$8	$10	$12	$14	$16	$19	$21	$23	$16	$5	$176
CUM INVESTMENT (1992M$)	$561	$663	$783	$924	$1,081	$1,244	$1,394	$1,512	$1,056	$357	
PLANT IN SERVICE	$0	$0	$0	$0	$0	$0	$0	$529	$739	$357	$1,626
NET BASIS FOR AFUDC	$561	$663	$783	$924	$1,081	$1,244	$1,394	$983	$317	$0	
ESCALATED PLANT COSTS	$225	$270	$321	$382	$426	$444	$402	$302	$183	$113	$4,260
AFUDC	$45	$54	$65	$77	$92	$107	$121	$133	$94	$32	$990
CUM INVESTMENT	$1,632	$1,956	$2,342	$2,801	$3,319	$3,870	$4,393	$4,828	$3,415	$1,170	
PLANT IN SERVICE	$0	$0	$0	$0	$0	$0	$0	$1,690	$2,390	$1,170	$5,250
NET BASIS FOR AFUDC	$1,632	$1,956	$2,342	$2,801	$3,319	$3,870	$4,393	$3,138	$1,024	$0	

SECTION 4

MHTGR-GT/IC CAPITAL COST ESTIMATE RESULTS

The capital cost estimate for the MHTGR-GT/IC was developed on a differential basis, starting from the detailed bottom-up MHTGR-SC estimate previously described in Section 3. To facilitate comparisons and to maintain consistency with the EEDB Code of Accounts, the same capital cost categories were used for both the MHTGR-SC and MHTGR-GT/IC. Where MHTGR-GT/IC systems significantly differed from those of the MHTGR-SC, analogous systems were placed in the corresponding account categories. For example, the secondary helium hot leg piping and isolation valve between the IHX and the turbomachine were included in Account 233, Main and Auxiliary Steam System. Similarly, the power conversion loop heat exchangers (recuperator, intercoolers, precooler) and the secondary helium cold leg piping and isolation valve were included in Account 234, Feedwater and Condensate System. Using this approach, the base construction costs, overnight costs and total capital costs for the Prototype, Replica and Target MHTGR-GT/IC Plants are addressed in the following sections.

4.1 PLANT BASE CONSTRUCTION COSTS

The base construction costs for the MHTGR-GT/IC Prototype Plant Lead Module with common facilities and the completed Prototype, Replica and Target (NOAK) Plants are summarized at the two-digit EEDB cost account level in Tables 4-1(a), 4-1(b), 4-1(c) and 4-1(d), respectively. Additional detail at the three digit cost account level is provided in Appendix C, Tables C-5, C-6, C-7 and C-8, respectively.

Comparison with the prior MHTGR-SC cost estimate reveals the following significant differences by EEDB account.

Account 21 - Structures and Improvements - The modest increase (under 7%) in the structures and improvements account largely arises from the increased size of the IHX, compared to the steam generator. This, in turn, requires that both the diameter and depth of the reactor module enclosure be correspondingly increased. The additional loads resulting from the increased weight of the IHX, relative to the steam generator are a further basis for increased costs. The increased cost of the reactor complex is offset to a small extent by the reduced overall size and cost of the turbine complex.

Account 22 - Reactor Plant Equipment - The reactor plant equipment cost is significantly increased (23%), relative to the MHTGR-SC. There are several contributors to this increase, however, the largest increment is for the heat transport system. The heat transport system includes both the IHX and main circulator. The IHX is larger than the steam generator and also uses more expensive materials (Inconel 617 for the IHX vs 2¼Cr-1Mo and Alloy 800H for the steam generator). The main circulator for the MHTGR-GT/IC has about twice the power requirements of the MHTGR-SC circulator and is based upon a dual motor design. The vessel system is also significantly increased in the MHTGR-GT/IC, reflecting both a change of materials (from low alloy steel to 9Cr-1Mo-V) and an increase in vessel size (mostly for the IHX vessel, although the reactor vessel size increases slightly). The reactor service system cost also increases, due to the increased

size of the main circulator and the additional service requirements of the IHX. Lesser increases are found in reactor system and shutdown cooling system, due to the increased normal operating temperatures of the reactor. One item that decreases is the reactor control, protection and monitoring system. The small decrease reflects the elimination of the steam isolation and dump function and a somewhat simpler control system.

Account 23 - Turbine Plant Equipment - Overall the turbine plant equipment accounts increase by about 70-80%, relative to the steam cycle. The largest increase is associated with the secondary heat exchangers and cold leg piping, which are included in Account 234. In the MHTGR-GT/IC there are four secondary heat exchangers, the recuperator, precooler and two intercoolers, each contained within individual pressure vessels. The precooler is split into two trains, each in its own pressure vessel. This compares with one heat exchanger, the condenser, in the MHTGR-SC. The cold leg isolation valve is also included in this category. Other differences in this category are smaller, and overall offsetting.

Account 24 - Electric Plant Equipment - Differences in the electrical plant equipment category are relatively modest. They primarily relate to the greater protective requirements of the gas turbomachine (Account 244) and the greater electrical output of the MHTGR-GT/IC concept.

Account 25 - Miscellaneous Plant Equipment - There are no significant differences in this account.

Account 26 - Heat Rejection System - There is a significant reduction in the heat rejection system account for the MHTGR-GT/IC. This is largely attributable to the increased efficiency and reduced heat rejection requirements of the MHTGR-GT/IC concept.

Overall, the total direct costs of the MHTGR-GT/IC Prototype, Replica and Target Plant increase by some 26%, 26% and 24%, respectively, relative to the comparable MHTGR-SC plants.

Factory equipment costs in the NI represent over 32% of the base construction cost for the Lead Module and ECA equipment costs represent an additional 11%. The Prototype Plant equipment costs rise as a percentage of total base construction costs to 40% for the NI and more than 12% for the ECA, primarily due to the common facilities. The MHTGR-GT/IC Target Plant factory equipment percentages change slightly to nearly 41% for NI factory equipment and nearly 14% for the ECA factory equipment primarily due to the application of learning on NI equipment specific to the MHTGR.

Direct site material represents approximately 6 to 7% of total base construction costs for the MHTGR-GT/IC Prototype Plant. As no learning is applied to the bulk materials, the direct site material cost is identical for the four module Prototype, Replica, and Target Plants while total direct costs decline due to the application of learning. Direct site labor costs as a percentage of total direct costs vary from over 8% for the Lead Module to nearly 10% for the Prototype Plant. The MHTGR-GT/IC Target Plant direct site labor is 15% of total direct cost and 11% of total base construction costs.

Total direct costs as a percentage of base construction costs varies from over 67% on the Lead Module to nearly 73% on the MHTGR-GT/IC Target Plant. This increase in the direct cost contribution is due to elimination of design efforts required for the Lead Module and the assumption that standardization and certification of the design is successful and multiple MHTGR orders are placed by the vendor team to supplier organizations. As a result, substantial reductions are obtained in home office engineering. Reductions in construction services and field office services are also accomplished, in part due to the reduced field labor hours calculated due to learning. The reactor vendor Home Office Engineering estimates were provided by GA. The remainder of the NI indirects were based on an algorithm developed by BNI and is related primarily to field labor hours, although plant schedule and equipment/material procurement also impact the NI indirects. For the ECA, SWEC estimated indirects, based on their scope in the ECA and experience with non-nuclear projects, and GCRA developed the owner's costs as documented in Reference 13.

A comparison of the base construction costs and percentage of total plant cost by 3 digit EEDB account for the Prototype, Replica, and Target Plants is given in Table 4-2. Table 4-2 also illustrates the plant to plant account cost reductions due to elimination of FOAK costs and application of learning. A summary of nuclear island, energy conversion area, and total base construction costs by direct and indirect cost categories is given in Table 4-3. Tables 4-2 and 4-3 show that in evolving from the Prototype to the Target Plant, the NI base construction costs decline by 22%, the ECA base construction costs decline by about 11% and the total plant costs decline by more than 20%.

Table 4-2 also shows that the major reductions in the NI costs occur in Account 22, Reactor Plant Equipment, and in the indirect costs with the largest indirect cost reduction being in Account 92, Home Office Engineering. The reduction in the reactor plant equipment account is attributable to FOAK equipment costs and equipment cost reductions due to learning. The reduction in the indirect costs is attributed to FOAK design costs, standardization and learning.

Table 4-3 also shows that, in evolving from the Prototype to the Target Plant, the ECA direct costs reduce on the order of 9.2%. This cost reduction is attributed to learning applied to the turbomachine and recuperators, the improvement in site labor productivity assumed due to the National Labor Alliance and implementation of rolling 4 x 10 schedules for the Target Plant, and to site labor learning. The contribution of site learning is minimal as the ECA contains standard commercial equipment and is constructed in accordance with standard commercial practice. More sizeable reductions occur in the indirect costs. As in the NI, the largest reduction occurs in the Home Office Engineering account which declines by over 63%, and is attributable to design standardization and replication.

In summary, the 20.1% cost reduction achieved in moving from the Prototype to the Target Plant is comprised of:

- 1.8% due to equipment FOAKs
- 4.3% due to reactor equipment learning
- 2.2% due to turbomachine and other equipment learning
- 0.9% due to construction learning and improvements in productivity

- 2.8% due to owner's cost reduction primarily due to reduced staffing requirements
- 3.4% due to design and licensing indirect account FOAKs
- 4.7% due to learning and design standardization in the indirect accounts

4.1.1 Site Labor Costs

The data in Table 4-3 indicate that direct site labor costs account for between 10% and 11% of the total base construction costs. The percentage rises from the Prototype Plant to the Target Plant because equipment and indirect FOAK costs and equipment learning reduces plant costs at a faster rate than the learning applied to field labor. Overall direct site labor is a minor contributor to overall base construction costs. However, the indirect labor cost algorithm used by BNI to estimate NI indirects is also directly related to site labor cost.

Tables 4-4(a), 4-4(b), 4-4(c), and 4-4(d) provide a summary of crew manhours by 2 digit EEDB account for the NI and ECA for the four plant scenarios examined. The MHTGR-GT/IC Lead Module site labor manhours are estimated to be nearly 3.3 million, of which nearly 2.2 million are associated with NI construction. Relative to the MHTGR-SC Lead Module, the MHTGR-GT/IC site labor manhours are lower by 100,000 manhours, consisting of an increase of over 109,000 manhours in the NI and a 210,000 reduction in the ECA. For the four module Target Plant, the total site labor manhours increase to over 6.4 million, of which 4.5 million are related to NI construction. The MHTGR construction activities are heavily weighted towards structures and improvements relative to other nuclear concepts. Over 40% of the Lead Module and over 41% of the Target Plant manhours are associated with NI structures and improvements. An additional 7 to 10% of total manhours are involved in ECA structures and improvements. Whereas typical nuclear power plants have much more piping, equipment, and electrical installation manhours, the MHTGR is dominated by construction of structures and improvements. Historically, there has been less schedule and cost risk associated with installation of concrete and steel for buildings relative to the installation of piping, equipment, and electrical items inside the completed structures.

For the MHTGR-GT/IC Target Plant, nearly 21% of the total manhours involve the electrical crew, 13% the mechanical crew, 15% the piping crew, and 3% for the instrument crew. The instrument crew is newly defined in the 1993 cost estimate update and the manhours reported here would have been reported in prior estimates as electrical crew. Related to structures and improvements, over 32% of the total manhours involved the concrete crew, 9% for the structural crew, and over 5% for the engineering crew.

The MHTGR-GT/IC design has not taken full advantage of modularization potential in the design estimated in this report. Structures and improvements dominate the NI cost and limited applications of modularization have been incorporated in the NI design, primarily skid mounted equipment modules. No effort has been undertaken to investigate or incorporate modular design features into the ECA as of this date even though the potential cost savings and manpower reductions were noted in 1990 in the MHTGR Cost Reduction Report (Reference 5). With the evolution of standardized, modular fossil and nuclear plant ECA designs, the MHTGR-GT/IC is recognized to have further cost reduction potential and may take advantage of advances in these areas. The expected cost

reductions would be embodied in further reductions in site labor manhours, offset somewhat by increases in factory equipment costs and corresponding reductions in plant indirect costs to the extent these costs are directly related to field labor costs.

Tables 4-5(a), 4-5(b), 4-5(c), and 4-5(d) presents the breakdown of site craft labor manhours in a similar format to Tables 4-4(a)-(d) based on the crew mix specified in Table 1-2. All of the cost accounts show reductions in the labor man-hours due to learning in going from the Prototype Plant to the Target Plant.

Tables 4-6(a), 4-6(b), 4-6(c), and 4-6(d) provide a different look at the site craft labor breakdown for the MHTGR-GT/IC Lead Module, Prototype, Replica and Target Plants, respectively. The labor man-hours are summarized by craft at the two-digit account level for each of the plants in for the following crafts: boilermakers, carpenters, electricians, ironworkers, laborers, millwrights, operating engineers, pipefitters, teamsters, and other craft labor. The data in these tables indicate the most highly utilized crafts to be pipefitters accounting for about 22% of the total direct labor hours on the Prototype, Replica and Target Plants. The next most utilized crafts are electricians at 18%, iron workers at 15%, laborers and carpenters at 13% and operating engineers at 9%. All of the other crafts combined account for the remaining 9% of craft labor hours on the MHTGR-GT/IC Target plant.

Application of the same labor rates used in the USCEA Study (Reference 9) nuclear cost estimates would result in a $11.6 million reduction in MHTGR-GT/IC Prototype Plant direct labor costs. The MHTGR-GT/IC Target Plant direct labor costs would be reduced by $10.6 million.

4.1.2 Factory Equipment and Site Material Costs

Summaries of the factory equipment and site material direct costs by EEDB account for the MHTGR-GT/IC Prototype, Replica and Target (NOAK) Plants are provided in Table 4-3. The factory equipment direct costs account for about 52-55% of the total base construction costs. The site material costs account for about 6-7% of the total base construction costs.

Table 4-3 also shows that nuclear island factory equipment costs amount to over 39% of total base construction costs, over 60% of which is contained in Account 22, Reactor Plant Equipment. The second most significant factory equipment account is the Turbine Plant Equipment, Account 23, which contains nearly 30% of the total factory equipment costs and over 16% of total base construction costs. The higher cost of the helium turbomachine, secondary system heat exchangers, vessels, and piping, plus auxiliary equipment is included in Account 23.

The only factory equipment accounts which contain any reductions in costs in evolving from the Lead to the Target Plant are Reactor Plant Equipment, Account 22 and the Turbine Plant Equipment, Account 23. Table 4-7 details the major reactor plant equipment items included in the reactor manufacturer scope and the turbomachine and related equipment has also been included. Table 4-7 itemizes the learning factors applied, factory FOAK costs, and equipment cost details for the Lead Module, Prototype, Replica,

and Target Plants. Learning is applied at the 94% factory equipment guideline for all reactor equipment except the reactor and intermediate heat exchanger vessels, the intermediate and shutdown cooling heat exchangers, the turbomachine, and the major equipment transportation costs. No learning is applied to the equipment transportation costs. A 96% learning factor was identified for the turbomachine due to similarities with current commercial combustion turbine manufacturing experience. A 98% learning factor is applied to the vessels and a 96% learning factor is applied to the heat exchangers to recover facility capital costs over a 12 year operating life, the production of 44 units. The 12 year recovery period is projected to be conservative relative to other reactor plant equipment and yields substantially higher Target Plant equipment costs relative to the default 94% learning curve offered in the guidelines. Changing the vessels learning factor from 96 to 98% increased Target Plant direct costs by $11 million. The direct cost impact of changing the heat exchanger learning factor from 94% to 96% was a $7 million increase. The more conservative learning factors applied to the vessels and heat exchangers result in a $22.7 million increase in MHTGR-GT/IC overnight costs (a 1.6% increase). The Reactor Plant Equipment account also contains equipment FOAK costs of $31 million, excluding contingency.

FOAK design, tooling and setup costs of $0.5 million have been included in the MHTGR-GT/IC Lead Module turbomachine costs and a 96% learning curve has been applied. An additional $2 million in FOAKs has been included for the modular recuperator sections and a 94% learning curve has also been applied to the recuperators. No other reductions in cost occur in the other factory equipment accounts as the equipment is assumed to be commercially available.

Table 4-3 also shows that NI site materials cost comprise 4-5% of total base construction costs and the ECA site materials comprise 2-3% of total base construction costs. Nearly 50% of the direct site material costs are associated with NI structures and improvements and more than 11% associated with ECA structures and improvements. No learning factors are applied to site materials.

To permit comparison on a bulk basis of selected site materials (i.e., commodities) with alternative plants, bulk commodity data are given in Table 4-8 for the MHTGR-GT/IC Lead Module and in Table 4-9 for the MHTGR-GT/IC Target Plant. The Prototype and Replica Plants have the same quantities as the Target Plant. The data in Tables 4-8 and 4-9 is provided by 2-digit EEDB Account for the NI, ECA and total plant. The structural materials identified in Tables 4-8 and 4-9 are assumed to be non-nuclear for the purposes of costing consistent with the ACI 318 construction code approach. As the NI structures are only required to maintain their structural integrity and are not designed to maintain a pressure boundary, the lower non-nuclear costs are appropriate. Other materials in the NI are nuclear grade, and carry the higher nuclear commodity prices and installation manhour rates.

4.1.3 Indirect Costs

The indirect cost estimates were developed by BNI, GA, GCRA, and SWEC. GA estimated the reactor module engineering & services, Account 920, covering indirect costs associated with supply of the reactor plant equipment. BNI developed the indirect

costs for the NI design and construction. SWEC developed the indirect costs for the ECA design and construction. GCRA prepared the owner's cost estimate, Account 94.

FOAK indirect costs to support the Lead Module design and construction were estimated to be $6 million for the reactor manufacturer's scope, $40 million for the NI design and construction scope, and $15 million for the ECA design and construction scope. These FOAK costs are costs incurred over and above the standard design and licensing costs and cover completion of system and structural designs beyond that required for licensing and the FDA, preparation of procurement specifications, construction and fabrication drawings, construction procedures and sequencing, startup procedures, and other details required for construction. Construction of following reactor modules would use this information directly due to the standardized, replicated design.

Recurring MHTGR RM indirects were estimated by GA to be nearly $16 million per module with a 76% learning curve, the same as the MHTGR-SC and MHTGR-GT/DC. The RM indirects for the Prototype Plant were estimated to be nearly $47 million. Due to replication of the standardized, certified design and the streamlined Target Plant construction schedule, the Target Plant RM indirects were estimated to fall to $18 million. Recurring RM indirects were estimated to be less than 8% of total RM equipment direct costs for the Prototype Plant and 3.4% for the Target Plant. These reductions in cost are realizable only if the groundrule assumptions hold, that is, no changes in regulations or design and no funding restrictions during construction.

Recurring architect engineering NI indirects were estimated by BNI and included support to obtain site specific permits and licenses, as described in Section 3.1.3. The total recurring NI indirects were estimated by the algorithm to be $135 million for the Lead Module, over 29% of total direct costs. Application of field learning and the shortened construction schedule led to reductions in recurring NI indirects in following commercial plants. The estimated recurring architect engineering NI indirects were $224, $169, and $165 million for the Prototype, Replica, and Target Plants, respectively. NI indirect costs range from nearly 25% of total NI directs and over 18% of total plant directs for the Prototype Plant to 21% and 16%, respectively for the Target Plant.

Recurring architect engineering ECA indirects were estimated by SWEC based on experience with other non-nuclear projects. The recurring ECA indirects were estimated to be over $28 million for the Lead Module and $62 million for the Prototype, Replica, and Target Plants. These costs represent approximately 19% of the ECA direct cost and nearly 6% of total plant direct costs.

The Reference 3 DOE cost estimating guidelines encourage a detailed, task related estimate. Because of the aforementioned difficulties in relating historical experience with the groundrule scenario and providing supportable, technology related adjustments, a high priority should be placed on developing the scope of work contained in all the indirects and their corresponding costs in the next overall cost estimate update effort. This effort should address both FOAK and recurring costs under the guidelines, especially as these costs may be related to historical experience on one-of-a-kind LWR plant designs.

The Owner's costs (Account 94) in the MHTGR base construction cost estimates were developed on a bottom-up basis, Reference 13, and a summary of the results is

given in Table 4-10. These results indicate that the owner's cost could range from over 12% of the other direct and indirect costs for the Prototype Plant to over 11% of the other direct and indirect costs for the Target Plant. A spare recuperator section has been added to the MHTGR-GT/IC spare parts allotment. A spare turbomachine was not considered necessary, similar to the MHTGR-SC.

4.1.4 Summary of MHTGR-GT/IC Base Construction Costs

Table 4-11 provides a breakdown of MHTGR-GT/IC Target Plant base construction costs at the three digit level by cost estimating organization. Additional detail is provided for the reactor complex buildings, Account 212. The percentage contribution of each cost account to the total base construction costs is also noted together with the percentage by estimator. For the MHTGR-GT/IC, 73% of the total base construction cost is direct cost and 27% is estimated to be indirect costs. Reactor plant equipment, Account 22 represents 36% of the total base construction costs. Turbine plant equipment, Account 23 at 18%, and structures and improvements, Account 21 at 11%, are the next largest contributors to MHTGR-GT/IC Target Plant capital cost. Land and owner's costs are estimated to be 10% OF MHTGR-GT/IC base construction cost.

MHTGR-GT/IC Target Plant base construction costs are estimated to be $1,455 million. Tables 4-1, 4-2, and 4-3 identify total base construction costs for the four MHTGR-GT/IC plant scenarios estimated. Total base construction costs for the Lead Module, Prototype and Replica Plants are $775, $1,821, and $1,569 million, respectively.

4.2 OVERNIGHT CONSTRUCTION COSTS

Overnight construction costs are obtained by adding contingency to the base construction costs. The MHTGR-GT/IC cost estimate is based on nearly 1500 line item entries defining equipment, systems, bulk commodities, with their associated quantities, unit costs and installation manhours. Each of these line items carries a contingency factor to achieve a 50% confidence estimate. Table 4-12 provides a breakdown of MHTGR-GT/IC contingency costs by three digit cost account for the Lead Module, Prototype, Replica, and Target Plants. These costs were calculated by summing all the individual line item contingencies, and the percentages were calculated by dividing the total account contingency by the account base construction cost. The total contingency estimated for the MHTGR-GT/IC Lead Module is $164 million or 21.2% of total base construction costs. The MHTGR-GT/IC Target Plant contingency is estimated to be $310 million or 21.3% of total base construction costs.

The Reference 3 Guidelines specified a default contingency of 25% for nuclear and 15% for conventional construction items and allows insertion of different contingencies if justified. Many of the accounts show the default 15% contingency and most other accounts have a contingency between 15% and 25% due to the combination of nuclear and conventional construction items. Major primary system components including the reactor vessel, intermediate heat exchanger (IHX) vessel, and heat transport system internals were assigned a 25% contingency. The metallic reactor internals were assigned a 35% contingency. The IHX and shutdown cooling heat exchanger were assigned a

30% contingency. A 15% contingency based on ABB/CENP's experience with large nuclear class vessels for LWR's was assigned to the pressure relief, vessel supports, and transportation accounts. A 25% contingency was applied to all reactor system components and the reactor service equipment received a much higher average contingency (32-34%) due to perceived uncertainties in the scope of the estimate. A 25% contingency was also included for the turbomachine. The average contingency percentage on each account varies slightly from plant to plant in Table 4-12 due to the learning applied and the line item contingencies assigned. The contingency applied in this table does not include an allowance for indeterminates, which is already included in the base construction cost estimate.

4.3 TOTAL CAPITAL COSTS

The cost of invested capital is added to the overnight capital costs to account for estimated plant cash flows and the time value of money. Allowance for funds used during construction (AFUDC) includes the interest paid on debt and preferred stock and a return on investment for common stock. The cost of money identified in Table 1-6 is used to calculate interest during construction. The methodology for calculating interest during construction (IDC) is specified in References 2 and 3. Based on an assumed utility financial structure, the average cost of money before taxes is 11.35%, or 6.05% real (inflation-adjusted).

Table 4-13(a), 4-13(b), and 4-13(c) summarize the Prototype, Replica, and Target Plant capital cost estimates, respectively, including capital cost estimate breakdown at the 2 digit account level, contingency, and interest during construction. In addition, these tables provide a comparison with the MHTGR-SC and MHTGR-GT/DC plant cost estimates at the 2 digit level. The percentage increase or decrease of the MHTGR-GT/IC cost estimate relative to the MHTGR-SC and MHTGR-GT/IC cost estimates is also included for information. Based on adjustments to the MHTGR-SC quarterly cash flows provided in Table 3-14, the interest during construction is estimated to be $438 million for the Prototype Plant, $240 million for the Replica Plant, and $216 million for the Target Plant. Interest during construction costs for the Prototype Plant were calculated using the utility financial structure and average cost of money presented in Table 1-6. It should be noted that the Reference MHTGR-GT/IC deployment scenario assumes government ownership of the Lead Module and interest during construction on the Lead Module would not be ordinarily included on a government project. For the purposes of consistency the Lead Module interest during construction was included in the Prototype Plant as if all four modules were constructed by an investor owned utility with the Table 1-6 financial structure. The resultant total capital cost estimates for the MHTGR-GT/IC Prototype Plant is $2,651 million or $3,290/kW. The Replica Plant total capital plant cost is reduced to $2,144 million or $2,659/kW resulting from elimination of Lead Module design and factory FOAKs, reductions in the overall construction schedule, and the impact of learning on MHTGR specific equipment and field installation labor. For the MHTGR-GT/IC Target Plant, representing the 21st through 24th reactor modules, total capital costs are estimated to be $1,981 million or $2,458/kW. The Target Plant cost reductions are achieved through additional learning on factory fabricated equipment and field installation labor.

The MHTGR-GT/IC Target Plant, with higher capital costs due the addition of the IHX, secondary helium piping and equipment is 22% more costly than the MHTGR-SC but only 5% more expensive in terms of $/kW due to the increased output of the higher efficiency gas turbomachine. The MHTGR-GT/IC is 18% more expensive than the MHTGR-GT/DC and 28% more expensive in unit capital cost.

TABLE 4-1(a)
MHTGR-GT/IC LEAD MODULE BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
21	STRUCTURES & IMPROVEMENTS	3,755,500	1,318,152	31,974,909	23,274,838	59,005,247	4,798,365	327,390	8,294,977	4,821,338	17,914,680	76,919,927
22	REACTOR PLANT EQUIPMENT	219,604,150	330,679	8,365,455	3,794,002	231,763,607	5,082,700	23,408	584,668	350,252	6,017,620	237,781,227
23	TURBINE PLANT EQUIPMENT	25,670,000	5,480	145,822	44,000	25,859,822	48,748,658	199,673	5,018,900	2,273,975	56,041,533	81,901,355
24	ELECTRIC PLANT EQUIPMENT	1,527,150	233,819	6,301,423	6,136	7,834,709	5,805,540	70,703	1,896,893	1,436,108	9,138,541	16,973,250
25	MISCELLANEOUS PLANT EQUIPMENT	1,983,800	291,914	7,312,840	4,161,811	13,458,451	9,860,350	350,384	8,679,841	3,394,427	21,934,618	35,393,069
26	HEAT REJECTION SYSTEM	0	0	0	0	0	2,858,200	128,028	3,176,594	1,700,572	7,735,366	7,735,366
2	TOTAL DIRECT COSTS	252,540,600	2,180,044	54,100,449	31,280,787	337,921,836	77,153,813	1,099,586	27,651,873	15,976,672	120,782,358	458,704,194
91	CONSTRUCTION SERVICES	0	0	37,875,213	16,232,234	54,107,447	0	0	0	22,320,000	22,320,000	76,427,447
92	ENGINEERING AND HOME OFFICE SERVICES	21,644,000	0	79,978,928	0	101,622,928	0	0	15,500,000	992,500	16,492,500	118,115,428
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	17,859,301	3,401,772	21,261,072	0	0	0	5,106,250	5,106,250	26,367,322
94	OWNER'S COSTS	0	0	0	0	0	0	0	53,926,779	40,991,644	94,918,423	94,918,423
9	TOTAL INDIRECT COSTS	21,644,000	0	135,713,442	19,634,006	176,991,448	0	0	69,426,779	69,410,394	138,837,173	315,828,621
	TOTAL BASE CONSTRUCTION COST	274,184,600	2,180,044	189,813,891	50,914,793	514,913,284	77,153,813	1,099,586	97,078,652	85,387,066	259,619,531	774,532,815

TABLE 4-1(b)
MHTGR-GT/IC PROTOTYPE PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
21	STRUCTURES & IMPROVEMENTS	12,268,000	2,953,596	71,472,941	52,004,703	135,745,644	6,770,700	536,081	13,705,286	11,620,196	32,096,182	167,841,826
22	REACTOR PLANT EQUIPMENT	600,557,751	829,808	21,063,850	9,233,731	630,855,332	6,042,700	31,755	794,500	653,159	7,490,359	638,345,691
23	TURBINE PLANT EQUIPMENT	96,622,906	5,480	145,822	44,000	96,812,728	179,849,765	665,260	16,726,008	8,857,166	205,432,939	302,245,667
24	ELECTRIC PLANT EQUIPMENT	6,108,600	813,080	21,912,503	24,544	28,045,647	16,630,260	209,742	5,643,986	5,601,692	27,875,938	55,921,585
25	MISCELLANEOUS PLANT EQUIPMENT	3,365,840	325,491	8,140,476	5,511,601	17,017,917	10,741,350	389,407	9,671,734	3,543,464	23,956,548	40,974,465
26	HEAT REJECTION SYSTEM	0	0	0	0	0	7,933,200	340,388	8,424,759	5,569,342	21,927,301	21,927,301
2	TOTAL DIRECT COSTS	718,923,097	4,927,455	122,735,592	66,818,579	908,477,268	227,967,975	2,172,633	54,966,273	37,845,019	320,779,267	1,229,256,535
91	CONSTRUCTION SERVICES	0	0	77,313,835	33,134,501	110,448,335	0	0	0	38,040,000	38,040,000	148,488,335
92	ENGINEERING AND HOME OFFICE SERVICES	52,719,324	0	107,052,317	0	159,771,641	0	0	15,500,000	3,970,000	19,470,000	179,241,641
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	39,151,718	7,457,470	46,609,188	0	0	0	20,425,000	20,425,000	67,034,188
94	OWNER'S COSTS	0	0	0	0	0	0	0	81,410,715	115,968,917	197,379,632	197,379,632
9	TOTAL INDIRECT COSTS	52,719,324	0	223,517,869	40,591,971	316,829,164	0	0	96,910,715	178,403,917	275,314,632	592,143,796
	TOTAL BASE CONSTRUCTION COST	771,642,421	4,927,455	346,253,461	107,410,550	1,225,306,432	227,967,975	2,172,633	151,876,988	216,248,936	596,093,899	1,821,400,331

TABLE 4-1(c)
MHTGR-GT/IC REPLICA PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
21	STRUCTURES & IMPROVEMENTS	12,268,000	2,766,757	66,956,652	52,004,703	131,229,355	6,770,700	509,415	13,017,816	11,620,196	31,408,712	162,638,067
22	REACTOR PLANT EQUIPMENT	530,487,616	774,148	19,649,036	9,233,731	559,370,383	6,042,700	30,481	762,552	653,159	7,458,411	566,828,794
23	TURBINE PLANT EQUIPMENT	90,256,560	5,370	142,896	44,000	90,443,456	166,811,279	616,214	15,492,840	8,857,166	191,161,285	281,604,741
24	ELECTRIC PLANT EQUIPMENT	6,106,600	752,555	20,281,359	24,544	26,414,503	16,630,260	194,922	5,244,766	5,601,692	27,476,718	53,891,221
25	MISCELLANEOUS PLANT EQUIPMENT	3,359,960	316,415	7,914,409	5,511,601	16,785,970	10,741,350	378,633	9,402,416	3,543,464	23,687,230	40,473,200
26	HEAT REJECTION SYSTEM	0	0	0	0	0	7,933,200	315,258	7,802,765	5,569,342	21,305,307	21,305,307
2	TOTAL DIRECT COSTS	642,480,736	4,615,245	114,944,352	66,818,579	824,243,667	214,929,489	2,044,923	51,723,155	37,845,019	304,497,663	1,128,741,330
91	CONSTRUCTION SERVICES	0	0	61,311,938	26,276,545	87,588,483	0	0	0	38,040,000	38,040,000	125,628,483
92	ENGINEERING AND HOME OFFICE SERVICES	30,098,323	0	40,538,199	0	70,636,521	0	0	0	3,970,000	3,970,000	74,606,521
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	34,197,480	6,513,806	40,711,286	0	0	0	20,425,000	20,425,000	61,136,286
94	OWNER'S COSTS	0	0	0	0	0	0	0	57,319,277	121,638,150	178,957,427	178,957,427
9	TOTAL INDIRECT COSTS	30,098,323	0	136,047,616	32,790,350	198,936,290	0	0	57,319,277	184,073,150	241,392,427	440,328,717
	TOTAL BASE CONSTRUCTION COST	672,579,058	4,615,245	250,991,968	99,608,929	1,023,179,956	214,929,489	2,044,923	109,042,432	221,918,169	545,890,090	1,569,070,046

TABLE 4-1(d)
MHTGR-GT/IC TARGET PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
21	STRUCTURES & IMPROVEMENTS	12,268,000	2,679,555	64,846,359	52,004,703	129,119,062	6,770,700	493,356	12,607,442	11,620,196	30,998,338	160,117,400
22	REACTOR PLANT EQUIPMENT	487,316,529	749,760	19,030,020	9,233,731	515,580,280	6,042,700	29,521	738,523	653,159	7,434,382	523,014,662
23	TURBINE PLANT EQUIPMENT	83,818,850	5,202	138,425	44,000	84,001,275	155,155,596	596,796	15,004,637	8,857,166	179,017,399	263,018,674
24	ELECTRIC PLANT EQUIPMENT	6,106,600	728,836	19,642,130	24,544	25,775,274	16,630,260	188,779	5,079,469	5,601,692	27,311,421	53,086,695
25	MISCELLANEOUS PLANT EQUIPMENT	3,351,354	306,447	7,665,090	5,511,601	16,528,045	10,741,350	366,692	9,105,868	3,543,464	23,390,702	39,918,747
26	HEAT REJECTION SYSTEM	0	0	0	0	0	7,933,200	305,324	7,556,886	5,569,342	21,059,428	21,059,428
2	TOTAL DIRECT COSTS	592,863,333	4,469,800	111,322,024	66,818,579	771,003,936	203,273,806	1,980,468	50,092,845	37,845,019	291,211,670	1,062,215,606
91	CONSTRUCTION SERVICES	0	0	59,739,847	25,602,792	85,342,639	0	0	0	38,040,000	38,040,000	123,382,639
92	ENGINEERING AND HOME OFFICE SERVICES	18,267,117	0	40,260,613	0	58,527,730	0	0	0	3,970,000	3,970,000	62,497,730
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	33,193,371	6,322,547	39,515,917	0	0	0	20,425,000	20,425,000	59,940,917
94	OWNER'S COSTS	0	0	0	0	0	0	0	38,403,233	108,740,380	147,143,613	147,143,613
9	TOTAL INDIRECT COSTS	18,267,117	0	133,193,831	31,925,339	183,386,286	0	0	38,403,233	171,175,380	209,578,613	392,964,899
	TOTAL BASE CONSTRUCTION COST	611,130,450	4,469,800	244,515,855	98,743,918	954,390,222	203,273,806	1,980,468	88,496,078	209,020,399	500,790,283	1,455,180,505

TABLE 4–2
MHTGR–GT/IC PLANT COSTS AND % BY ACCOUNT

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE								% CHANGE.	
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	PROTOTYPE 1992$	PROTOTYPE %	REPLICA 1992$	REPLICA %	TARGET 1992$	TARGET %	PROTOTYPE TO TARGET	REPLICA TO TARGET
20	LAND & LAND RIGHTS	2,000,000	0.1%	2,000,000	0.1%	2,000,000	0.1%	0.0%	0.0%
211	YARDWORK	6,921,326	0.4%	6,836,896	0.4%	6,706,490	0.5%	−3.1%	−1.9%
212	REACTOR COMPLEX	130,146,453	7.1%	125,696,010	8.0%	123,687,647	8.5%	−5.0%	−1.6%
213	TURBINE COMPLEX	22,748,203	1.2%	22,152,161	1.4%	21,883,339	1.5%	−3.8%	−1.2%
214	OPERATIONS CENTER	4,448,469	0.2%	4,411,344	0.3%	4,353,981	0.3%	−2.1%	−1.3%
215	REMOTE SHUTDOWN BUILDING	149,750	0.0%	147,965	0.0%	145,137	0.0%	−3.1%	−1.9%
216	OTHER BUILDINGS	3,427,625	0.2%	3,393,691	0.2%	3,340,806	0.2%	−2.5%	−1.6%
21	STRUCTURES & IMPROVEMENTS	167,841,826	9.2%	162,638,067	10.4%	160,117,400	11.0%	−4.6%	−1.5%
221	REACTOR SYSTEM	146,039,998	8.0%	125,305,855	8.0%	112,252,935	7.7%	−23.1%	−10.4%
222	VESSEL SYSTEM	160,014,257	8.8%	149,318,740	9.5%	143,002,059	9.8%	−10.6%	−4.2%
223	HEAT TRANSPORT SYSTEM	199,484,734	11.0%	173,967,685	11.1%	158,333,455	10.9%	−20.6%	−9.0%
224	SHUTDOWN COOLING SYSTEM	17,222,576	0.9%	14,619,796	0.9%	13,411,925	0.9%	−22.1%	−8.3%
225	SHUTDOWN COOLING WATER SYSTEM	5,027,187	0.3%	4,684,296	0.3%	4,394,893	0.3%	−12.6%	−6.2%
226	REACTOR CAVITY COOLING SYSTEM	17,135,490	0.9%	15,500,944	1.0%	14,445,579	1.0%	−15.7%	−6.8%
227	REACTOR SERVICE SYSTEM	64,515,257	3.5%	58,693,675	3.7%	54,270,592	3.7%	−15.9%	−7.5%
228	REACTOR CONTROL, PROTECTION & MONITORING	14,889,092	0.8%	13,445,806	0.9%	12,406,455	0.9%	−16.7%	−7.7%
229	REACTOR PLANT MISCELLANEOUS	14,017,100	0.8%	11,291,998	0.7%	10,496,770	0.7%	−25.1%	−7.0%
22	REACTOR PLANT EQUIPMENT	638,345,691	35.0%	566,828,794	36.1%	523,014,662	35.9%	−18.1%	−7.7%
231	TURBINE GENERATOR & AUXILIARIES	101,491,428	5.6%	94,822,464	6.0%	88,261,207	6.1%	−13.0%	−6.9%
233	MAIN & AUXILIARY STEAM SYSTEM	11,464,720	0.6%	11,257,933	0.7%	11,176,894	0.8%	−2.5%	−0.7%
234	FEEDWATER & CONDENSATE SYSTEM	162,936,252	8.9%	149,419,932	9.5%	137,576,988	9.5%	−15.6%	−7.9%
235	STARTUP & SHUTDOWN SYSTEM	0	0.0%	0	0.0%	0	0.0%	0.0%	0.0%
236	TURBINE PLANT SAMPLING SYSTEM	0	0.0%	0	0.0%	0	0.0%	0.0%	0.0%
237	ECA CONTROL, DATA & INSTRUMENTATION	26,353,267	1.4%	26,104,412	1.7%	26,003,585	1.8%	−1.3%	−0.4%
23	TURBINE PLANT EQUIPMENT	302,245,667	16.6%	281,604,741	17.9%	263,018,674	18.1%	−13.0%	−6.6%
241	SWITCHGEAR	7,356,697	0.4%	7,282,585	0.5%	7,253,289	0.5%	−1.4%	−0.4%
242	STATION SERVICE EQUIPMENT	13,984,422	0.8%	13,875,209	0.9%	13,826,526	1.0%	−1.1%	−0.4%
243	SWITCHBOARDS	4,104,324	0.2%	4,095,623	0.3%	4,092,252	0.3%	−0.3%	−0.1%
244	PROTECTIVE EQUIPMENT	1,075,601	0.1%	1,028,815	0.1%	1,007,686	0.1%	−6.3%	−2.1%
245	ELECTRIC STRUCTURES & WIRING CONTAINERS	14,938,534	0.8%	13,900,178	0.9%	13,493,289	0.9%	−9.7%	−2.9%
246	POWER AND CONTROL WIRING	14,462,007	0.8%	13,708,811	0.9%	13,413,653	0.9%	−7.2%	−2.2%
24	ELECTRIC PLANT EQUIPMENT	55,921,585	3.1%	53,891,221	3.4%	53,086,695	3.6%	−5.1%	−1.5%

TABLE 4–2
MHTGR–GT/IC PLANT COSTS AND % BY ACCOUNT

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE								% CHANGE	
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	PROTOTYPE 1992$	PROTOTYPE %	REPLICA 1992$	REPLICA %	TARGET 1992$	TARGET %	PROTOTYPE TO TARGET	REPLICA TO TARGET
251	TRANSPORTATION AND LIFT EQUIPMENT	2,473,437	0.1%	2,458,217	0.2%	2,447,334	0.2%	−1.1%	−0.4%
252	AIR, WATER, AND STEAM SERVICE SYSTEM	31,962,404	1.8%	31,526,336	2.0%	31,033,486	2.1%	−2.9%	−1.6%
253	COMMUNICATIONS AND SECURITY EQUIPMENT	4,634,959	0.3%	4,587,736	0.3%	4,541,260	0.3%	−2.0%	−1.0%
254	FURNISHINGS AND FIXTURES	1,903,665	0.1%	1,900,911	0.1%	1,896,667	0.1%	−0.4%	−0.2%
25	MISCELLANEOUS PLANT EQUIPMENT	40,974,465	2.2%	40,473,200	2.6%	39,918,747	2.7%	−2.6%	−1.4%
261	CIRCULATING AND SERVICE WATER PUMPHOUSE	509,941	0.0%	487,016	0.0%	478,080	0.0%	−6.2%	−1.8%
262	ECA COOLING WATER SYSTEMS	3,727,139	0.2%	3,604,651	0.2%	3,556,652	0.2%	−4.6%	−1.3%
263	CIRCULATING AND SERVICE WATER SYSTEM	17,690,221	1.0%	17,213,640	1.1%	17,024,696	1.2%	−3.8%	−1.1%
26	HEAT REJECTION SYSTEM	21,927,301	1.2%	21,305,307	1.4%	21,059,428	1.4%	−4.0%	−1.2%
2	TOTAL DIRECT COSTS	1,229,256,535	67.5%	1,128,741,330	71.9%	1,062,215,606	73.0%	−13.6%	−5.9%
911	TEMPORARY CONSTRUCTION FACILITIES	59,290,718	3.3%	48,546,587	3.1%	47,491,040	3.3%	−19.9%	−2.2%
912	CONSTRUCTION TOOLS AND EQUIPMENT	36,207,600	2.0%	30,721,236	2.0%	30,182,233	2.1%	−16.6%	−1.8%
913	PAYROLL INSURANCE AND TAXES	50,925,534	2.8%	44,524,775	2.8%	43,895,939	3.0%	−13.8%	−1.4%
914	PERMITS, INSURANCE, AND LOCAL TAXES	2,064,483	0.1%	1,835,885	0.1%	1,813,426	0.1%	−12.2%	−1.2%
91	CONSTRUCTION SERVICES	148,488,335	8.2%	125,628,483	8.0%	123,382,639	8.5%	−16.9%	−1.8%
920	REACTOR MODULE ENGINEERING AND SERVICES	52,719,324	2.9%	30,096,323	1.9%	18,267,117	1.3%	−65.4%	−39.3%
921	PLANT ENGINEERING AND SERVICES	102,889,238	5.6%	33,003,649	2.1%	32,795,459	2.3%	−68.1%	−0.6%
922	HOME OFFICE QUALITY ASSURANCE	1,676,308	0.1%	1,013,455	0.1%	1,006,515	0.1%	−40.0%	−0.7%
923	HOME OFFICE PROJECT & CONSTRUCTION MGMT.	21,956,771	1.2%	10,491,095	0.7%	10,428,638	0.7%	−52.5%	−0.6%
92	ENGINEERING AND HOME OFFICE SERVICES	179,241,641	9.8%	74,606,521	4.8%	62,497,730	4.3%	−65.1%	−16.2%
931	FIELD OFFICE EXPENSES	7,425,286	0.4%	6,599,580	0.4%	6,432,228	0.4%	−13.4%	−2.5%
932	FIELD JOB SUPERVISION	44,935,053	2.5%	41,691,207	2.7%	41,033,755	2.8%	−8.7%	−1.6%
933	FIELD QUALITY ASSURANCE/QUALITY CONTROL	2,330,459	0.1%	2,035,564	0.1%	1,975,796	0.1%	−15.2%	−2.9%
934	PLANT STARTUP AND TEST	12,343,389	0.7%	10,809,934	0.7%	10,499,139	0.7%	−14.9%	−2.9%
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	67,034,188	3.7%	61,136,286	3.9%	59,940,917	4.1%	−10.6%	−2.0%
941	PROJECT MANAGEMENT EXPENSES	21,969,402	1.2%	9,672,650	0.6%	7,917,168	0.5%	−64.0%	−18.1%
942	FEES, TAXES, AND INSURANCE	60,150,000	3.3%	68,550,000	4.4%	59,760,000	4.1%	−0.6%	−12.8%
943	SPARE PARTS AND CAPITAL EQUIPMENT	40,077,350	2.2%	38,583,758	2.5%	37,303,759	2.6%	−6.9%	−3.3%
944	STAFF TRAINING AND STARTUP	57,283,363	3.1%	47,750,051	3.0%	30,764,824	2.1%	−46.3%	−35.6%
945	GENERAL & ADMINISTRATIVE	17,899,517	1.0%	14,400,969	0.9%	11,397,863	0.8%	−36.3%	−20.9%
94	OWNER'S COSTS	197,379,632	10.8%	178,957,427	11.4%	147,143,613	10.1%	−25.5%	−17.8%
9	TOTAL INDIRECT COSTS	592,143,796	32.5%	440,328,717	28.1%	392,964,899	27.0%	−33.6%	−10.8%
	TOTAL BASE CONSTRUCTION COST	1,821,400,331	100.0%	1,569,070,046	100.0%	1,455,180,505	100.0%	−20.1%	−7.3%

TABLE 4–3
SUMMARY MHTGR–GT/IC COSTS BY COST CATEGORY

COST CATEGORY	PROTOTYPE		REPLICA		TARGET		% CHANGE	
	COST	% OF TOTAL	COST	% OF TOTAL	COST	% OF TOTAL	PROTOTYPE TO TARGET	REPLICA TO TARGET
NUCLEAR ISLAND (NI)								
FACTORY EQUIPMENT	718,923,097	39.5%	642,480,736	40.9%	592,863,333	40.7%	−17.5%	−7.7%
SITE LABOR COST	122,735,592	6.7%	114,944,352	7.3%	111,322,024	7.7%	−9.3%	−3.2%
SITE MATERIAL	66,818,579	3.7%	66,818,579	4.3%	66,818,579	4.6%	0.0%	0.0%
TOTAL NI DIRECT COST	908,477,268	49.9%	824,243,667	52.5%	771,003,936	53.0%	−15.1%	−6.5%
CONSTRUCTION SERVICES	110,448,335	6.1%	87,588,483	5.6%	85,342,639	5.9%	−22.7%	−2.6%
HOME OFFICE ENGINEERING & SERVICES	159,771,641	8.8%	70,636,521	4.5%	58,527,730	4.0%	−63.4%	−17.1%
FIELD OFFICE AND SERVICES	46,609,188	2.6%	40,711,286	2.6%	39,515,917	2.7%	−15.2%	−2.9%
TOTAL NI INDIRECT COST	316,829,164	17.4%	198,936,290	12.7%	183,386,286	12.6%	−42.1%	−7.8%
TOTAL NI BASE CONSTRUCTION COST	1,225,306,432	67.3%	1,023,179,956	65.2%	954,390,222	65.6%	−22.1%	−6.7%
ENERGY CONVERSION AREA (ECA)								
FACTORY EQUIPMENT	227,967,975	12.5%	214,929,489	13.7%	203,273,806	14.0%	−10.8%	−5.4%
SITE LABOR COST	54,966,273	3.0%	51,723,155	3.3%	50,092,845	3.4%	−8.9%	−3.2%
SITE MATERIAL	37,845,019	2.1%	37,845,019	2.4%	37,845,019	2.6%	0.0%	0.0%
TOTAL ECA DIRECT COST	320,779,267	17.6%	304,497,663	19.4%	291,211,670	20.0%	−9.2%	−4.4%
CONSTRUCTION SERVICES	38,040,000	2.1%	38,040,000	2.4%	38,040,000	2.6%	0.0%	0.0%
HOME OFFICE ENGINEERING & SERVICES	19,470,000	1.1%	3,970,000	0.3%	3,970,000	0.3%	−79.6%	0.0%
FIELD OFFICE AND SERVICES	20,425,000	1.1%	20,425,000	1.3%	20,425,000	1.4%	0.0%	0.0%
TOTAL ECA INDIRECT COST	77,935,000	4.3%	62,435,000	4.0%	62,435,000	4.3%	−19.9%	0.0%
TOTAL ECA BASE CONSTRUCTION COST	398,714,267	21.9%	366,932,663	23.4%	353,646,670	24.3%	−11.3%	−3.6%
TOTAL PLANT								
FACTORY EQUIPMENT	946,891,072	52.0%	857,410,225	54.6%	796,137,139	54.7%	−15.9%	−7.1%
SITE LABOR COST	177,701,865	9.8%	166,667,507	10.6%	161,414,869	11.1%	−9.2%	−3.2%
SITE MATERIAL	104,663,598	5.7%	104,663,598	6.7%	104,663,598	7.2%	0.0%	0.0%
TOTAL PLANT DIRECT COST	1,229,256,535	67.5%	1,128,741,330	71.9%	1,062,215,606	73.0%	−13.6%	−5.9%
CONSTRUCTION SERVICES	148,488,335	8.2%	125,628,483	8.0%	123,382,639	8.5%	−16.9%	−1.8%
HOME OFFICE ENGINEERING & SERVICES	179,241,641	9.8%	74,606,521	4.8%	62,497,730	4.3%	−65.1%	−16.2%
FIELD OFFICE AND SERVICES	67,034,188	3.7%	61,136,286	3.9%	59,940,917	4.1%	−10.6%	−2.0%
OWNER'S COSTS	197,379,632	3.7%	178,957,427	3.9%	147,143,613	4.1%	−25.5%	−17.8%
TOTAL PLANT INDIRECT COST	592,143,796	32.5%	440,328,717	28.1%	392,964,899	27.0%	−33.6%	−10.8%
TOTAL PLANT CONSTRUCTION COST	1,821,400,331	100.0%	1,569,070,046	100.0%	1,455,180,505	100.0%	−20.1%	−7.3%

TABLE 4–4(a)
MHTGR–GT/IC LEAD MODULE CREW MANHOURS

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	ENGINEER CREW	STRUCTURAL CREW	CONCRETE CREW	PIPING CREW	MECHANICAL CREW	ELECTRICAL CREW	INSTRUMENT CREW	TOTAL MANHOURS
	NUCLEAR ISLAND								
21	STRUCTURES & IMPROVEMENTS	174,402	171,703	836,667	21,982	5,755	107,643	0	1,318,152
22	REACTOR PLANT EQUIPMENT	34	33,271	318	108,644	129,456	27,654	31,302	330,679
23	TURBINE PLANT EQUIPMENT	0	0	0	0	0	0	5,480	5,480
24	ELECTRIC PLANT EQUIPMENT	0	0	0	0	0	233,819	0	233,819
25	MISCELLANEOUS PLANT EQUIPMENT	0	1,968	0	246,876	29,808	0	13,262	291,914
26	HEAT REJECTION SYSTEM								0
2	SUBTOTAL NUCLEAR ISLAND	174,436	206,942	836,985	377,502	165,019	369,116	50,044	2,180,044
	ENERGY CONVERSION AREA								
21	STRUCTURES & IMPROVEMENTS	25,270	135,841	112,247	0	8,371	45,661	0	327,390
22	REACTOR PLANT EQUIPMENT	0	0	0	10,290	10,410	0	2,708	23,408
23	TURBINE PLANT EQUIPMENT	0	220	7,671	107,670	48,412	0	35,700	199,673
24	ELECTRIC PLANT EQUIPMENT	1,131	550	0	980	517	67,525	0	70,703
25	MISCELLANEOUS PLANT EQUIPMENT	5,323	140	2,211	27,337	278,071	37,302	0	350,384
26	HEAT REJECTION SYSTEM	9,530	3,988	34,261	39,303	18,276	22,670	0	128,028
2	SUBTOTAL ENERGY CONVERSION AREA	41,254	140,739	156,390	185,580	364,057	173,158	38,408	1,099,586
	TOTAL MANHOURS	215,690	347,681	993,375	563,082	529,076	542,274	88,452	3,279,630

TABLE 4–4(b)
MHTGR–GT/IC PROTOTYPE PLANT CREW MANHOURS

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	ENGINEER CREW	STRUCTURAL CREW	CONCRETE CREW	PIPING CREW	MECHANICAL CREW	ELECTRICAL CREW	INSTRUMENT CREW	TOTAL MANHOURS
	NUCLEAR ISLAND								
21	STRUCTURES & IMPROVEMENTS	314,619	291,121	2,045,064	51,703	17,687	233,402	0	2,953,596
22	REACTOR PLANT EQUIPMENT	34	107,541	318	230,549	326,957	86,350	78,059	829,808
23	TURBINE PLANT EQUIPMENT	0	0	0	0	0	0	5,480	5,480
24	ELECTRIC PLANT EQUIPMENT	0	0	0	0	0	813,080	0	813,080
25	MISCELLANEOUS PLANT EQUIPMENT	0	1,968	0	246,876	61,165	0	15,482	325,491
26	HEAT REJECTION SYSTEM								0
2	SUBTOTAL NUCLEAR ISLAND	314,653	400,630	2,045,382	529,128	405,809	1,132,832	99,021	4,927,455
	ENERGY CONVERSION AREA								
21	STRUCTURES & IMPROVEMENTS	32,402	243,014	154,013	0	16,670	89,982	0	536,081
22	REACTOR PLANT EQUIPMENT	0	0	0	15,397	12,392	0	3,966	31,755
23	TURBINE PLANT EQUIPMENT	0	220	26,544	349,326	165,027	0	124,143	665,260
24	ELECTRIC PLANT EQUIPMENT	1,131	550	0	980	517	206,564	0	209,742
25	MISCELLANEOUS PLANT EQUIPMENT	5,323	487	2,211	56,238	279,671	45,477	0	389,407
26	HEAT REJECTION SYSTEM	28,108	12,342	69,205	133,821	56,718	40,194	0	340,388
2	SUBTOTAL ENERGY CONVERSION AREA	66,964	256,613	251,973	555,762	530,995	382,217	128,109	2,172,633
	TOTAL MANHOURS	381,617	657,243	2,297,355	1,084,890	936,804	1,515,049	227,130	7,100,088

TABLE 4–4(c)
MHTGR–GT/IC REPLICA PLANT CREW MANHOURS

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	ENGINEER CREW	STRUCTURAL CREW	CONCRETE CREW	PIPING CREW	MECHANICAL CREW	ELECTRICAL CREW	INSTRUMENT CREW	TOTAL MANHOURS
	NUCLEAR ISLAND								
21	STRUCTURES & IMPROVEMENTS	297,411	275,572	1,910,030	48,400	16,425	218,919	0	2,766,757
22	REACTOR PLANT EQUIPMENT	34	99,718	313	215,752	305,329	80,097	72,905	774,148
23	TURBINE PLANT EQUIPMENT	0	0	0	0	0	0	5,370	5,370
24	ELECTRIC PLANT EQUIPMENT	0	0	0	0	0	752,555	0	752,555
25	MISCELLANEOUS PLANT EQUIPMENT	0	1,928	0	241,938	57,546	0	15,003	316,415
26	HEAT REJECTION SYSTEM								0
2	SUBTOTAL NUCLEAR ISLAND	297,445	377,218	1,910,343	506,090	379,300	1,051,571	93,278	4,615,245
	ENERGY CONVERSION AREA								
21	STRUCTURES & IMPROVEMENTS	31,211	229,964	147,740	0	15,704	84,796	0	509,415
22	REACTOR PLANT EQUIPMENT	0	0	0	14,697	11,992	0	3,792	30,481
23	TURBINE PLANT EQUIPMENT	0	216	24,568	323,767	152,762	0	114,901	616,214
24	ELECTRIC PLANT EQUIPMENT	1,108	539	0	960	507	191,808	0	194,922
25	MISCELLANEOUS PLANT EQUIPMENT	5,219	451	2,166	52,905	273,949	43,943	0	378,633
26	HEAT REJECTION SYSTEM	26,016	11,422	64,053	123,922	52,643	37,202	0	315,258
2	SUBTOTAL ENERGY CONVERSION AREA	63,554	242,592	238,527	516,251	507,557	357,749	118,693	2,044,923
	TOTAL MANHOURS	360,999	619,810	2,148,870	1,022,341	886,857	1,409,320	211,971	6,660,168

TABLE 4–4(d)
MHTGR–GT/IC TARGET PLANT CREW MANHOURS

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	ENGINEER CREW	STRUCTURAL CREW	CONCRETE CREW	PIPING CREW	MECHANICAL CREW	ELECTRICAL CREW	INSTRUMENT CREW	TOTAL MANHOURS
	NUCLEAR ISLAND								
21	STRUCTURES & IMPROVEMENTS	288,035	266,890	1,849,829	46,873	15,907	212,021	0	2,679,555
22	REACTOR PLANT EQUIPMENT	32	96,577	302	208,953	295,714	77,572	70,810	749,760
23	TURBINE PLANT EQUIPMENT	0	0	0	0	0	0	5,202	5,202
24	ELECTRIC PLANT EQUIPMENT	0	0	0	0	0	728,836	0	728,836
25	MISCELLANEOUS PLANT EQUIPMENT	0	1,870	0	234,313	55,735	0	14,529	306,447
26	HEAT REJECTION SYSTEM								0
2	SUBTOTAL NUCLEAR ISLAND	288,067	365,337	1,850,131	490,139	367,356	1,018,429	90,341	4,469,800
	ENERGY CONVERSION AREA								
21	STRUCTURES & IMPROVEMENTS	30,226	222,716	143,084	0	15,207	82,123	0	493,356
22	REACTOR PLANT EQUIPMENT	0	0	0	14,236	11,615	0	3,670	29,521
23	TURBINE PLANT EQUIPMENT	0	209	23,795	313,565	147,947	0	111,280	596,796
24	ELECTRIC PLANT EQUIPMENT	1,074	522	0	930	491	185,762	0	188,779
25	MISCELLANEOUS PLANT EQUIPMENT	5,054	436	2,097	51,238	265,310	42,557	0	366,692
26	HEAT REJECTION SYSTEM	25,197	11,063	62,035	120,015	50,985	36,029	0	305,324
2	SUBTOTAL ENERGY CONVERSION AREA	61,551	234,946	231,011	499,984	491,555	346,471	114,950	1,980,468
	TOTAL MANHOURS	349,618	600,283	2,081,142	990,123	858,911	1,364,900	205,291	6,450,268

TABLE 4-5(a)
MHTGR-GT/IC LEAD MODULE CRAFT MANHOURS BY AREA

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	BOILERMAKER	CARPENTER	ELECTRICIAN	IRONWORKER	LABORER	MILLWRIGHT	OPERATING ENGINEER	PIPE FITTER	TEAMSTER	OTHER	TOTALS
	NUCLEAR ISLAND											
21	STRUCTURES & IMPROVEMENTS	3,297	343,252	75,350	298,309	364,226	5,496	134,283	42,438	9,667	41,833	1,318,152
22	REACTOR PLANT EQUIPMENT	16,297	2,417	49,406	35,881	2,092	27,161	38,340	149,333	9,734	16	330,679
23	TURBINE PLANT EQUIPMENT	0	110	5,261	0	55	0	55	0	0	0	5,480
24	ELECTRIC PLANT EQUIPMENT	0	0	163,673	0	0	0	4,676	65,469	0	0	233,819
25	MISCELLANEOUS PLANT EQUIPMENT	37,031	364	12,732	26,164	231	61,719	34,524	110,253	8,897	0	291,914
26	HEAT REJECTION SYSTEM	0	0	0	0	0	0	0	0	0	0	0
2	SUBTOTAL NUCLEAR ISLAND	56,625	346,142	306,423	360,354	366,605	94,376	211,879	367,493	28,298	41,849	2,180,044
	ENERGY CONVERSION AREA											
21	STRUCTURES & IMPROVEMENTS	0	51,691	31,963	124,330	55,628	0	37,002	19,482	1,682	5,612	327,390
22	REACTOR PLANT EQUIPMENT	1,544	54	2,600	1,029	27	2,573	2,823	11,930	829	0	23,408
23	TURBINE PLANT EQUIPMENT	16,151	3,793	34,272	12,466	2,669	26,918	20,956	76,414	5,651	384	199,673
24	ELECTRIC PLANT EQUIPMENT	147	28	47,268	511	706	245	2,024	19,664	112	0	70,703
25	MISCELLANEOUS PLANT EQUIPMENT	4,101	891	26,111	3,281	3,864	6,834	47,732	242,469	14,990	111	350,384
26	HEAT REJECTION SYSTEM	5,895	13,904	15,869	13,774	16,196	9,826	13,558	34,724	2,569	1,713	128,028
2	SUBTOTAL ENERGY CONVERSION AREA	27,837	70,361	158,082	155,390	79,090	46,395	124,095	404,683	25,833	7,820	1,099,586
	TOTAL MANHOURS	84,462	416,503	464,506	515,744	445,695	140,771	335,974	772,176	54,131	49,669	3,279,630

TABLE 4-5(b)
MHTGR-GT/IC PROTOTYPE PLANT CRAFT MANHOURS BY AREA

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	BOILERMAKER	CARPENTER	ELECTRICIAN	IRONWORKER	LABORER	MILLWRIGHT	OPERATING ENGINEER	PIPE FITTER	TEAMSTER	OTHER	TOTALS
	NUCLEAR ISLAND											
21	STRUCTURES & IMPROVEMENTS	7,755	832,582	163,381	632,524	816,847	12,926	269,563	97,596	18,166	102,253	2,953,596
22	REACTOR PLANT EQUIPMENT	34,582	7,065	135,382	103,774	6,273	57,637	95,376	366,436	23,266	16	829,808
23	TURBINE PLANT EQUIPMENT	0	110	5,261	0	55	0	55	0	0	0	5,480
24	ELECTRIC PLANT EQUIPMENT	0	0	569,156	0	0	0	16,262	227,662	0	0	813,080
25	MISCELLANEOUS PLANT EQUIPMENT	37,031	408	14,863	26,164	253	61,719	39,250	135,339	10,465	0	325,491
26	HEAT REJECTION SYSTEM	0	0	0	0	0	0	0	0	0	0	0
2	SUBTOTAL NUCLEAR ISLAND	79,369	840,165	888,043	762,462	823,428	132,282	420,506	827,035	51,897	102,269	4,927,455
	ENERGY CONVERSION AREA											
21	STRUCTURES & IMPROVEMENTS	0	73,756	62,987	213,063	77,796	0	59,794	38,531	2,454	7,701	536,081
22	REACTOR PLANT EQUIPMENT	2,310	79	3,807	1,540	40	3,849	3,746	15,303	1,082	0	31,755
23	TURBINE PLANT EQUIPMENT	52,399	13,111	119,177	40,406	9,216	87,332	69,275	254,286	18,731	1,327	665,260
24	ELECTRIC PLANT EQUIPMENT	147	28	144,595	511	706	245	4,805	58,595	112	0	209,742
25	MISCELLANEOUS PLANT EQUIPMENT	8,436	909	31,834	6,431	3,881	14,060	51,655	256,154	15,937	111	389,407
26	HEAT REJECTION SYSTEM	20,073	28,299	28,136	36,480	38,243	33,455	40,519	103,466	8,256	3,460	340,388
2	SUBTOTAL ENERGY CONVERSION AREA	83,364	116,182	390,537	298,431	129,882	138,941	229,794	726,333	46,571	12,599	2,172,633
	TOTAL MANHOURS	162,734	956,347	1,278,579	1,060,892	953,310	271,223	650,300	1,553,368	98,468	114,868	7,100,088

TABLE 4-5(c)
MHTGR-GT/IC REPLICA PLANT CRAFT MANHOURS BY AREA

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	BOILERMAKER	CARPENTER	ELECTRICIAN	IRONWORKER	LABORER	MILLWRIGHT	OPERATING ENGINEER	PIPE FITTER	TEAMSTER	OTHER	TOTALS
	NUCLEAR ISLAND											
21	STRUCTURES & IMPROVEMENTS	7,260	777,791	153,243	593,525	765,234	12,100	253,581	91,377	17,144	95,502	2,766,757
22	REACTOR PLANT EQUIPMENT	32,363	6,569	126,057	96,426	5,829	53,938	89,006	342,204	21,741	16	774,148
23	TURBINE PLANT EQUIPMENT	0	107	5,155	0	54	0	54	0	0	0	5,370
24	ELECTRIC PLANT EQUIPMENT	0	0	526,789	0	0	0	15,051	210,715	0	0	752,555
25	MISCELLANEOUS PLANT EQUIPMENT	36,291	396	14,403	25,640	246	60,485	38,104	130,715	10,135	0	316,415
26	HEAT REJECTION SYSTEM	0	0	0	0	0	0	0	0	0	0	0
2	SUBTOTAL NUCLEAR ISLAND	75,914	784,864	825,647	715,591	771,364	126,523	395,796	775,011	49,020	95,517	4,615,245
	ENERGY CONVERSION AREA											
21	STRUCTURES & IMPROVEMENTS	0	70,594	59,357	202,021	74,547	0	56,857	36,306	2,346	7,387	509,415
22	REACTOR PLANT EQUIPMENT	2,205	76	3,640	1,470	38	3,674	3,600	14,738	1,041	0	30,481
23	TURBINE PLANT EQUIPMENT	48,565	12,136	110,305	37,452	8,530	80,942	64,176	235,528	17,351	1,228	616,214
24	ELECTRIC PLANT EQUIPMENT	144	27	134,266	500	692	240	4,496	54,448	110	0	194,922
25	MISCELLANEOUS PLANT EQUIPMENT	7,936	889	30,760	6,062	3,804	13,226	50,322	249,980	15,546	108	378,633
26	HEAT REJECTION SYSTEM	18,588	26,192	26,041	33,769	35,397	30,981	37,533	95,904	7,651	3,203	315,258
2	SUBTOTAL ENERGY CONVERSION AREA	77,438	109,914	364,370	281,275	123,007	129,063	216,985	686,903	44,043	11,926	2,044,923
	TOTAL MANHOURS	153,351	894,778	1,190,016	996,866	894,371	255,585	612,780	1,461,915	93,063	107,444	6,660,168

TABLE 4-5(d)
MHTGR-GT/IC TARGET PLANT CRAFT MANHOURS BY AREA

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	BOILERMAKER	CARPENTER	ELECTRICIAN	IRONWORKER	LABORER	MILLWRIGHT	OPERATING ENGINEER	PIPE FITTER	TEAMSTER	OTHER	TOTALS
	NUCLEAR ISLAND											
21	STRUCTURES & IMPROVEMENTS	7,031	753,276	148,415	574,821	741,114	11,718	245,588	88,497	16,603	92,491	2,679,555
22	REACTOR PLANT EQUIPMENT	31,343	6,362	122,086	93,388	5,645	52,238	86,202	331,425	21,056	15	749,760
23	TURBINE PLANT EQUIPMENT	0	104	4,994	0	52	0	52	0	0	0	5,202
24	ELECTRIC PLANT EQUIPMENT	0	0	510,185	0	0	0	14,577	204,074	0	0	728,836
25	MISCELLANEOUS PLANT EQUIPMENT	35,147	384	13,948	24,834	239	58,578	36,904	126,598	9,816	0	306,447
26	HEAT REJECTION SYSTEM	0	0	0	0	0	0	0	0	0	0	0
2	SUBTOTAL NUCLEAR ISLAND	73,521	760,126	799,628	693,043	747,050	122,535	383,323	750,594	47,475	92,507	4,469,800
	ENERGY CONVERSION AREA											
21	STRUCTURES & IMPROVEMENTS	0	68,369	57,486	195,654	72,197	0	55,064	35,160	2,272	7,154	493,356
22	REACTOR PLANT EQUIPMENT	2,135	73	3,523	1,424	37	3,559	3,487	14,275	1,008	0	29,521
23	TURBINE PLANT EQUIPMENT	47,035	11,754	106,829	36,272	8,262	78,391	62,154	228,105	16,804	1,190	596,796
24	ELECTRIC PLANT EQUIPMENT	140	26	130,033	485	671	233	4,355	52,732	106	0	188,779
25	MISCELLANEOUS PLANT EQUIPMENT	7,686	861	29,790	5,870	3,683	12,810	48,735	242,097	15,055	105	366,692
26	HEAT REJECTION SYSTEM	18,002	25,367	25,220	32,706	34,282	30,004	36,350	92,881	7,410	3,102	305,324
2	SUBTOTAL ENERGY CONVERSION AREA	74,998	106,451	352,882	272,410	119,131	124,996	210,146	665,250	42,655	11,551	1,980,468
	TOTAL MANHOURS	148,518	866,577	1,152,509	965,453	866,180	247,531	593,468	1,415,844	90,130	104,057	6,450,268

TABLE 4-6(a)
MHTGR-GT/IC LEAD MODULE CRAFT MANHOURS BY ACCOUNT

CRAFT	ACCOUNT 21	ACCOUNT 22	ACCOUNT 23	ACCOUNT 24	ACCOUNT 25	ACCOUNT 26	TOTAL MANHOURS	% OF TOTAL
BOILERMAKER	3,297	17,840	16,151	147	41,132	5,895	84,462	2.6%
CARPENTER	394,943	2,471	3,903	28	1,255	13,904	416,503	12.7%
ELECTRICIAN	107,313	52,007	39,533	210,941	38,843	15,869	464,506	14.2%
IRONWORKER	422,639	36,910	12,466	511	29,445	13,774	515,744	15.7%
LABORER	419,855	2,119	2,724	706	4,095	16,196	445,695	13.6%
MILLWRIGHT	5,496	29,734	26,918	245	68,553	9,826	140,771	4.3%
OPERATING ENGINEER	171,285	41,164	21,011	6,700	82,256	13,558	335,974	10.2%
PIPEFITTER	61,920	161,263	76,414	85,133	352,722	34,724	772,176	23.5%
TEAMSTER	11,349	10,563	5,651	112	23,886	2,569	54,131	1.7%
OTHER	47,446	16	384	0	111	1,713	49,669	1.5%
TOTAL CRAFT MANHOURS	1,645,542	354,087	205,153	304,522	642,298	128,028	3,279,630	100.0%
% OF TOTAL	50.2%	10.8%	6.3%	9.3%	19.6%	3.9%	100.0%	N/A

TABLE 4-6(b)
MHTGR-GT/IC PROTOTYPE PLANT CRAFT MANHOURS BY ACCOUNT

CRAFT	ACCOUNT 21	ACCOUNT 22	ACCOUNT 23	ACCOUNT 24	ACCOUNT 25	ACCOUNT 26	TOTAL MANHOURS	% OF TOTAL
BOILERMAKER	7,755	36,892	52,399	147	45,467	20,073	162,734	2.3%
CARPENTER	906,338	7,145	13,221	28	1,317	28,299	956,347	13.5%
ELECTRICIAN	226,369	139,189	124,438	713,751	46,697	28,136	1,278,579	18.0%
IRONWORKER	845,587	105,314	40,406	511	32,595	36,480	1,060,892	14.9%
LABORER	894,642	6,313	9,270	706	4,135	38,243	953,310	13.4%
MILLWRIGHT	12,926	61,487	87,332	245	75,779	33,455	271,223	3.8%
OPERATING ENGINEER	329,357	99,122	69,330	21,066	90,905	40,519	650,300	9.2%
PIPEFITTER	136,129	381,738	254,286	286,257	391,492	103,466	1,553,368	21.9%
TEAMSTER	20,620	24,348	18,731	112	26,401	8,256	98,468	1.4%
OTHER	109,954	16	1,327	0	111	3,460	114,868	1.6%
TOTAL CRAFT MANHOURS	3,489,677	861,563	670,740	1,022,822	714,898	340,388	7,100,088	100.0%
% OF TOTAL	49.1%	12.1%	9.4%	14.4%	10.1%	4.8%	100.0%	N/A

TABLE 4-6(c)
MHTGR-GT/IC REPLICA PLANT CRAFT MANHOURS BY ACCOUNT

CRAFT	ACCOUNT 21	ACCOUNT 22	ACCOUNT 23	ACCOUNT 24	ACCOUNT 25	ACCOUNT 26	TOTAL MANHOURS	% OF TOTAL
BOILERMAKER	7,260	34,567	48,565	144	44,226	18,588	153,351	2.3%
CARPENTER	848,385	6,645	12,243	27	1,285	26,192	894,778	13.4%
ELECTRICIAN	212,601	129,697	115,460	661,054	45,163	26,041	1,190,016	17.9%
IRONWORKER	795,546	97,896	37,452	500	31,702	33,769	996,866	15.0%
LABORER	839,781	5,867	8,584	692	4,050	35,397	894,371	13.4%
MILLWRIGHT	12,100	57,612	80,942	240	73,711	30,981	255,585	3.8%
OPERATING ENGINEER	310,438	92,606	64,230	19,547	88,426	37,533	612,780	9.2%
PIPEFITTER	127,683	356,941	235,528	265,163	380,695	95,904	1,461,915	22.0%
TEAMSTER	19,490	22,781	17,351	110	25,681	7,651	93,063	1.4%
OTHER	102,889	16	1,228	0	108	3,203	107,444	1.6%
TOTAL CRAFT MANHOURS	3,276,172	804,629	621,584	947,477	695,048	315,258	6,660,168	100.0%
% OF TOTAL	49.2%	12.1%	9.3%	14.2%	10.4%	4.7%	100.0%	N/A

TABLE 4-6(d)
MHTGR-GT/IC TARGET PLANT CRAFT MANHOURS BY ACCOUNT

CRAFT	ACCOUNT 21	ACCOUNT 22	ACCOUNT 23	ACCOUNT 24	ACCOUNT 25	ACCOUNT 26	TOTAL MANHOURS	% OF TOTAL
BOILERMAKER	7,031	33,478	47,035	140	42,833	18,002	148,518	2.3%
CARPENTER	821,646	6,435	11,858	26	1,245	25,367	866,577	13.4%
ELECTRICIAN	205,901	125,609	111,823	640,219	43,738	25,220	1,152,509	17.9%
IRONWORKER	770,474	94,812	36,272	485	30,704	32,706	965,453	15.0%
LABORER	813,311	5,681	8,314	671	3,922	34,282	866,180	13.4%
MILLWRIGHT	11,718	55,797	78,391	233	71,388	30,004	247,531	3.8%
OPERATING ENGINEER	300,653	89,689	62,206	18,931	85,639	36,350	593,468	9.2%
PIPEFITTER	123,657	345,700	228,105	256,806	368,695	92,881	1,415,844	22.0%
TEAMSTER	18,875	22,064	16,804	106	24,871	7,410	90,130	1.4%
OTHER	99,646	15	1,190	0	105	3,102	104,057	1.6%
TOTAL CRAFT MANHOURS	3,172,911	779,281	601,998	917,615	673,139	305,324	6,450,268	100.0%
% OF TOTAL	49.2%	12.1%	9.3%	14.2%	10.4%	4.7%	100.0%	N/A
% CHANGE, FROM PROTOTYPE	-9.1%	-9.6%	-10.2%	-10.3%	-5.8%	-10.3%	-9.2%	N/A

TABLE 4–7
MHTGR–GT/IC REACTOR PLANT EQUIPMENT COSTS

ACCOUNT NUMBER	REACTOR PLANT EQUIPMENT	LEARNING FACTOR	EQUIPMENT FOAK COSTS	LEAD MODULE	LEAD MODULE W/FOAK	PROTOTYPE PLANT	PROTOTYPE W/FOAK	REPLICA PLANT	TARGET PLANT
221	REACTOR SYSTEM								
221.3111.	NEUTRON CONTROL	94.0%	1,400,000	3,799,000	5,199,000	14,170,974	15,570,974	12,876,677	11,510,013
221.31121.	GRAPHITE REACTOR INTERNALS	94.0%	4,263,000	8,713,000	12,976,000	32,501,104	36,764,104	29,532,637	26,398,194
221.31122	METALLIC REACTOR INTERNALS	94.0%	300,000	17,400,000	17,700,000	64,905,224	65,205,224	58,977,148	52,717,615
221.3113.	REACTOR CORE (W/O FUEL)	94.0%	1,850,000	3,830,000	5,680,000	14,286,610	16,136,610	12,981,752	11,603,935
221.1114.	REACTOR SERVICE EQUIPMENT	94.0%	701,000	9,792,000	10,493,000	9,792,000	10,493,000	9,204,480	8,344,646
222	VESSEL SYSTEM								
222.31211.	REACTOR VESSEL & CROSS VESSEL	96.0%	2,350,000	20,450,000	22,800,000	79,936,733	82,286,733	77,492,109	74,706,474
222.31212.	IHX VESSEL	96.0%	2,000,000	12,290,000	14,290,000	48,040,217	50,040,217	46,571,052	44,896,947
222.3122.	PRESSURE RELIEF	94.0%	320,000	1,010,000	1,330,000	3,767,487	4,087,487	3,423,386	3,060,045
222.3123.	VESSEL SUPPORTS	94.0%	0	3,800,000	3,800,000	14,174,704	14,174,704	12,880,067	11,513,042
223	HEAT TRANSPORT SYSTEM								
223.31310.	MAIN HELIUM CIRCULATOR	94.0%	5,300,000	23,000,000	28,300,000	85,794,261	91,094,261	77,958,299	69,684,203
223.31320.	INTERMEDIATE HEAT EXCHANGER	96.0%	3,670,000	22,100,000	25,770,000	84,398,737	88,068,737	79,247,913	73,595,414
223.31330.	HEAT TRANSPORT SYSTEM INTERNALS	94.0%	1,800,000	4,100,000	5,900,000	15,293,760	17,093,760	13,896,914	12,421,967
223.11340.	HTS SERVICE SYSTEM EQUIPMENT	94.0%	175,000	2,453,000	2,628,000	2,453,000	2,628,000	2,305,820	2,090,422
224	SHUTDOWN COOLING SYSTEM								
224.31410.	SHUTDOWN CIRCULATOR	94.0%	194,000	1,166,000	1,360,000	4,349,396	4,543,396	3,952,147	3,532,686
224.31420.	SHUTDOWN COOLING HEAT EXCHANGER	96.0%	920,000	2,280,000	3,200,000	8,707,200	9,627,200	8,175,803	7,592,649
224.31430.	SHUTDOWN COOLING SYSTEM CONTROLS	94.0%	168,000	416,000	584,000	1,551,757	1,719,757	1,410,028	1,260,375
224.11440.	SCS SERVICE EQUIPMENT	94.0%	175,000	392,000	567,000	392,000	567,000	368,480	334,059
227	REACTOR SERVICE SYSTEM								
227.12110.0	CORE REFUELING	94.0%	1,974,000	13,734,000	15,708,000	13,734,000	15,708,000	12,909,960	11,703,979
227.52110.2	CORE REFUELING	94.0%	0	7,336,000	7,336,000	14,231,840	14,231,840	13,132,799	11,798,956
227.12120.	SITE FUEL HANDLING	94.0%	158,000	2,860,000	3,018,000	2,860,000	3,018,000	2,688,400	2,437,264
227.32410.0	HELIUM PURIFICATION	94.0%	125,000	644,000	769,000	2,402,239	2,527,239	2,182,832	1,951,158
227.52410.2	HELIUM PURIFICATION	94.0%	0	229,000	229,000	444,260	444,260	409,952	368,315
228	PLANT CONTROL, PROTECTION, & MONITORING								
228.33100.0	REACTOR PROTECTION SYSTEM	94.0%	53,000	364,000	417,000	1,357,787	1,410,787	1,233,775	1,102,828
228.33300.0	INVESTMENT PROTECTION & INSTR	94.0%	105,000	469,000	574,000	1,749,457	1,854,457	1,589,671	1,420,952
228.33400.0	PLANT CONTROL SYSTEM INSTRUMENTATION	94.0%	108,000	1,639,000	1,747,000	6,113,774	6,221,774	5,555,376	4,965,757
228.53400.2	PLANT CONTROL SYSTEM INSTRUMENTATION	94.0%	0	0	0	0	0	0	0
228.33540.0	NI ANALYTICAL INSTRUMENTATION	94.0%	54,000	137,000	191,000	511,035	565,035	464,360	415,075
229	REACTOR PLANT MISCELLANEOUS ITEMS								
229.1001	REACTOR PLANT MISC. ITEMS	94.0%	0	5,000,000	5,000,000	5,000,000	5,000,000	4,700,000	4,260,951
229.10011.	CHECKOUT & STARTUP TEST EQUIPMENT	94.0%	1,311,000	2,479,000	3,790,000	2,479,000	3,790,000	2,330,260	2,112,579
229.10012.	MAINTENANCE MONITORING & ISI EQUIP	94.0%	261,000	1,491,000	1,752,000	1,491,000	1,752,000	1,401,540	1,270,616
229.30030.	TRANSPORTATION OF MAJOR EQUIPMENT	100.0%	610,000	530,000	1,140,000	2,120,000	2,730,000	2,120,000	2,120,000
23	TURBINE PLANT EQUIPMENT								
231.3	TURBOMACHINERY	96.0%	500,000	25,170,000	25,670,000	96,122,906	96,622,906	90,256,560	83,818,850
237.1	OVERALL PLANT CONTROL SYSTEM	94.0%	0	0	0	0	0	0	0
237.3	PLANT CONTROL & SAFETY VALVE SYSTEM	94.0%	0	0	0	0	0	0	0
	TOTAL DIRECT COST		30,845,000	199,073,000	229,918,000	635,132,462	665,977,462	592,230,200	545,009,967

TABLE 4-8
MHTGR-GT/IC LEAD MODULE BULK COMMODITIES

ACCOUNT NUMBER	FORMWORK (SF)	STRUCTURAL STEEL (TN)	REINFORCING STEEL (TN)	EMBEDDED STEEL (TN)	STRUCTURAL CONCRETE (CY)	CONCRETE FILL (CY)	CS PIPE <2.5" (LF)	CS PIPE >2" (LF)	SS PIPE <2.5" (LF)	SS PIPE >2" (LF)	CM PIPE >2" (LF)	POWER CABLE (LF)	CONTROL CABLE (LF)	CABLE TRAY (LF)
NI														
21	538,455	2,164	10,216	212	56,737		30	400						
22	260		5	0	35		8,800	7,150	500	750			90,000	
23														
24												478,188	130,200	10,500
25														
26														
SUBTOTAL NI	538,715	2,164	10,221	212	56,772	0	8,830	7,550	500	750	0	478,188	220,200	10,500
ECA														
21	51,528	1,146	739	19	10,046									
22									3,450	150				
23	6,870	0	66	2	569		540	3,775						
24								0				91,300	413,750	5,625
25	3,580	0	26	3	360		1,050	100	2,125	1,200				
26	19,468	2	371	4	4,883		650	7,100						
SUBTOTAL ECA	81,446	1,148	1,202	29	15,858	0	2,240	10,975	5,575	1,350	0	91,300	413,750	5,625
TOTAL PLANT														
21	589,983	3,310	10,955	232	66,783	0	30	400	0	0	0	0	0	0
22	260	0	5	0	35	0	8,800	7,150	3,950	900	0	0	90,000	0
23	6,870	0	66	2	569	0	540	3,775	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	569,488	543,950	16,125
25	3,580	0	26	3	360	0	1,050	100	2,125	1,200	0	0	0	0
26	19,468	2	371	4	4,883	0	650	7,100	0	0	0	0	0	0
TOTAL PLANT	620,161	3,312	11,423	242	72,630	0	11,070	18,525	6,075	2,100	0	569,488	633,950	16,125
UNITS	SF/MWe	TN/MWe	TN/MWe	TN/MWe	CY/MWe	CY/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe
NI	2,674	11	51	1	282	0	44	37	2	4	0	2,373	1,093	52
ECA	404	6	6	0	79	0	11	54	28	7	0	453	2,053	28
TOTAL PLANT	3,078	16	57	1	360	0	55	92	30	10	0	2,826	3,146	80

TABLE 4–9
MHTGR–GT/IC PLANT BULK COMMODITIES

ACCOUNT NUMBER	FORMWORK (SF)	STRUCTURAL STEEL (TN)	REINFORCING STEEL (TN)	EMBEDDED STEEL (TN)	STRUCTURAL CONCRETE (CY)	CONCRETE FILL (CY)	CS PIPE <2.5" (LF)	CS PIPE >2" (LF)	SS PIPE <2.5" (LF)	SS PIPE >2" (LF)	CM PIPE >2" (LF)	POWER CABLE (LF)	CONTROL CABLE (LF)	CABLE TRAY (LF)
NI														
21	1,421,580	3,750	29,909	618	138,657		120	1,600						
22	260		5	0	35		15,350	18,300	2,000	3,000			90,000	
23														
24												1,912,750	520,800	42,000
25														
26														
SUBTOTAL NI	1,421,840	3,750	29,914	618	138,692	0	15,470	19,900	2,000	3,000	0	1,912,750	610,800	42,000
ECA														
21	63,897	4,050	1,555	26	20,033									
22									6,000	150				
23	27,340	0	262	10	2,272		540	10,230						
24								0				365,200	1,655,000	22,500
25	3,580	0	26	3	360		4,050	100	5,500	1,200				
26	38,936	4	742	8	9,766		2,600	28,400						
SUBTOTAL ECA	133,753	4,054	2,585	47	32,431	0	7,190	38,730	11,500	1,350	0	365,200	1,655,000	22,500
TOTAL PLANT														
21	1,485,477	7,800	31,464	644	158,690	0	120	1,600	0	0	0	0	0	0
22	260	0	5	0	35	0	15,350	18,300	8,000	3,150	0	0	90,000	0
23	27,340	0	262	10	2,272	0	540	10,230	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	2,277,950	2,175,800	64,500
25	3,580	0	26	3	360	0	4,050	100	5,500	1,200	0	0	0	0
26	38,936	4	742	8	9,766	0	2,600	28,400	0	0	0	0	0	0
TOTAL PLANT	1,555,593	7,804	32,499	665	171,123	0	22,660	58,630	13,500	4,350	0	2,277,950	2,265,800	64,500
UNITS	SF/MWe	TN/MWe	TN/MWe	TN/MWe	CY/MWe	CY/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe
NI	1,764	5	37	1	172	0	19	25	2	4	0	2,373	758	52
ECA	166	5	3	0	40	0	9	48	14	2	0	453	2,053	28
TOTAL PLANT	1,930	10	40	1	212	0	28	73	17	5	0	2,826	2,811	80

TABLE 4–10
MHTGR–GT/IC OWNER'S COST ESTIMATE

OWNER'S COST ACCOUNT	LEAD MODULE	PROTOTYPE PLANT	REPLICA PLANT	TARGET PLANT
941.1 ENGINEERING/SITE MANAGEMENT	2,604,960	4,522,500	1,772,820	1,447,200
941.2 QUALITY ASSURANCE	2,147,985	3,632,108	1,496,340	1,363,568
941.3 PROJECT LICENSING	4,555,899	6,249,812	2,687,715	2,051,325
941.4 PROJECT MANAGEMENT & CONTROL	4,817,325	7,564,983	3,715,775	3,055,075
941 PROJECT MANAGEMENT	14,126,169	21,969,402	9,672,650	7,917,168
942.1 PROPERTY TAXES	0	40,000,000	59,000,000	52,000,000
942.2 LICENSING FEES & PERMITS	9,725,000	15,950,000	5,350,000	5,350,000
942.3 INSURANCE	0	4,200,000	4,200,000	2,410,000
942 FEES, TAXES, & INSURANCE	9,725,000	60,150,000	68,550,000	59,760,000
943.1 INITIAL SPARE PARTS INVENTORY	12,100,000	22,200,000	20,700,000	19,400,000
943.2 CONSUMABLES, SUPPLIES, & COOLANTS	800,181	2,577,350	2,583,758	2,603,759
943.3 PLANT EQUIPMENT & FURNISHINGS	10,700,000	15,300,000	15,300,000	15,300,000
943 SPARE PARTS AND CAPITAL EQUIPMENT	23,600,181	40,077,350	38,583,758	37,303,759
944.1 SITE STAFF TRAINING & STARTUP	32,766,683	48,822,525	40,170,200	25,476,948
944.2 MAINTENANCE MATERIALS	751,667	1,518,333	1,102,500	834,167
944.3 SUPPLIES & EXPENSES	2,836,538	6,942,505	6,477,351	4,453,709
944 STAFF TRAINING AND STARTUP	36,354,888	57,283,363	47,750,051	30,764,824
945 GENERAL AND ADMINISTRATIVE	11,112,186	17,899,517	14,400,969	11,397,863
TOTAL OWNERS COSTS	94,918,423	197,379,632	178,957,427	147,143,613

TABLE 4–11
MHTGR–GT/IC TARGET PLANT COST BY ESTIMATOR

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	COST ESTIMATOR					TOTAL COST	% OF TOTAL
		BNI	SWEC	GA	ABB–CE	GCRA		
20	LAND & LAND RIGHTS	0	0	0	0	2,000,000	2,000,000	0.14%
211	YARDWORK	3,750,480	2,956,010	0	0	0	6,706,490	0.46%
212.1	REACTOR BUILDING	103,353,616	0	0	0	0	103,353,616	7.10%
212.2	REACTOR AUXILIARY BUILDING	0	0	0	0	0	0	0.00%
212.3	REACTOR SERVICE BUILDING	14,073,563	0	0	0	0	14,073,563	0.97%
212.4	PERSONNEL SERVICE BUILDING	2,183,467	0	0	0	0	2,183,467	0.15%
212.5	RADWASTE BUILDING	4,077,001	0	0	0	0	4,077,001	0.28%
212	REACTOR COMPLEX	123,687,647	0	0	0	0	123,687,647	8.50%
213	TURBINE COMPLEX	0	21,883,339	0	0	0	21,883,339	1.50%
214	OPERATIONS CENTER	0	4,353,981	0	0	0	4,353,981	0.30%
215	REMOTE SHUTDOWN BUILDING	145,137	0	0	0	0	145,137	0.01%
216	OTHER BUILDINGS	1,535,798	1,805,008	0	0	0	3,340,806	0.23%
21	STRUCTURES & IMPROVEMENTS	129,119,062	30,998,338	0	0	0	160,117,400	11.00%
221	REACTOR SYSTEM	1,678,533	0	57,856,787	52,717,615	0	112,252,935	7.71%
222	VESSEL SYSTEM	8,825,550	0	0	134,176,509	0	143,002,059	9.83%
223	HEAT TRANSPORT SYSTEM	541,448	0	71,774,626	86,017,381	0	158,333,455	10.88%
224	SHUTDOWN COOLING SYSTEM	692,156	0	5,127,120	7,592,649	0	13,411,925	0.92%
225	SHUTDOWN COOLING WATER SYSTEM	4,394,893	0	0	0	0	4,394,893	0.30%
226	REACTOR CAVITY COOLING SYSTEM	14,445,579	0	0	0	0	14,445,579	0.99%
227	REACTOR SERVICE SYSTEM	18,850,425	7,160,494	28,259,673	0	0	54,270,592	3.73%
228	REACTOR CONTROL, PROTECTION & MONITORING	4,227,955	273,888	7,904,612	0	0	12,406,455	0.85%
229	REACTOR PLANT MISCELLANEOUS	732,624	0	3,383,195	6,380,951	0	10,496,770	0.72%
22	REACTOR PLANT EQUIPMENT	54,389,163	7,434,382	174,306,013	286,885,105	0	523,014,662	35.94%
231	TURBINE GENERATOR & AUXILIARIES	0	4,442,357	0	83,818,850	0	88,261,207	6.07%
233	MAIN & AUXILIARY STEAM SYSTEM	0	11,176,894	0	0	0	11,176,894	0.77%
234	FEEDWATER & CONDENSATE SYSTEM	0	137,576,988	0	0	0	137,576,988	9.45%
235	STARTUP & SHUTDOWN SYSTEM	0	0	0	0	0	0	0.00%
236	TURBINE PLANT SAMPLING SYSTEM	0	0	0	0	0	0	0.00%
237	ECA CONTROL, DATA & INSTRUMENTATION	182,425	25,821,160	0	0	0	26,003,585	1.79%
23	TURBINE PLANT EQUIPMENT	182,425	179,017,399	0	83,818,850	0	263,018,674	18.07%
241	SWITCHGEAR	331,808	6,921,481	0	0	0	7,253,289	0.50%
242	STATION SERVICE EQUIPMENT	7,076,473	6,750,053	0	0	0	13,826,526	0.95%
243	SWITCHBOARDS	20,186	4,072,066	0	0	0	4,092,252	0.28%
244	PROTECTIVE EQUIPMENT	0	1,007,686	0	0	0	1,007,686	0.07%
245	ELECTRIC STRUCTURES & WIRING CONTAINERS	11,295,797	2,197,492	0	0	0	13,493,289	0.93%
246	POWER AND CONTROL WIRING	7,051,010	6,362,643	0	0	0	13,413,653	0.92%
24	ELECTRIC PLANT EQUIPMENT	25,775,274	27,311,421	0	0	0	53,086,695	3.65%
251	TRANSPORTATION AND LIFT EQUIPMENT	1,814,380	632,954	0	0	0	2,447,334	0.17%
252	AIR, WATER, AND STEAM SERVICE SYSTEM	10,998,744	20,034,742	0	0	0	31,033,486	2.13%
253	COMMUNICATIONS AND SECURITY EQUIPMENT	2,354,178	2,187,082	0	0	0	4,541,260	0.31%
254	FURNISHINGS AND FIXTURES	1,360,743	535,924	0	0	0	1,896,667	0.13%
25	MISCELLANEOUS PLANT EQUIPMENT	16,528,045	23,390,702	0	0	0	39,918,747	2.74%
261	CIRCULATING AND SERVICE WATER PUMPHOUSE	0	478,080	0	0	0	478,080	0.03%
262	ECA COOLING WATER SYSTEMS	0	3,556,652	0	0	0	3,556,652	0.24%
263	CIRCULATING AND SERVICE WATER SYSTEM	0	17,024,696	0	0	0	17,024,696	1.17%
26	HEAT REJECTION SYSTEM	0	21,059,428	0	0	0	21,059,428	1.45%
2	TOTAL DIRECT COSTS	225,993,969	289,211,670	174,306,013	370,703,954	2,000,000	1,062,215,606	73.00%
911	TEMPORARY CONSTRUCTION FACILITIES	40,111,040	7,380,000	0	0	0	47,491,040	3.26%
912	CONSTRUCTION TOOLS AND EQUIPMENT	20,482,233	9,700,000	0	0	0	30,182,233	2.07%
913	PAYROLL INSURANCE AND TAXES	23,895,939	20,000,000	0	0	0	43,895,939	3.02%
914	PERMITS, INSURANCE, AND LOCAL TAXES	853,426	960,000	0	0	0	1,813,426	0.12%
91	CONSTRUCTION SERVICES	85,342,639	38,040,000	0	0	0	123,382,639	8.48%
920	REACTOR MODULE ENGINEERING AND SERVICES	0	0	18,267,117	0	0	18,267,117	1.26%
921	PLANT ENGINEERING AND SERVICES	30,195,459	2,600,000	0	0	0	32,795,459	2.25%
922	HOME OFFICE QUALITY ASSURANCE	1,006,515	0	0	0	0	1,006,515	0.07%
923	HOME OFFICE PROJECT & CONSTRUCTION MGMT.	9,058,638	1,370,000	0	0	0	10,428,638	0.72%
92	ENGINEERING AND HOME OFFICE SERVICES	40,260,613	3,970,000	18,267,117	0	0	62,497,730	4.29%
931	FIELD OFFICE EXPENSES	5,532,228	900,000	0	0	0	6,432,228	0.44%
932	FIELD JOB SUPERVISION	21,733,755	19,300,000	0	0	0	41,033,755	2.82%
933	FIELD QUALITY ASSURANCE/QUALITY CONTROL	1,975,796	0	0	0	0	1,975,796	0.14%
934	PLANT STARTUP AND TEST	10,274,139	225,000	0	0	0	10,499,139	0.72%
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	39,515,917	20,425,000	0	0	0	59,940,917	4.12%
941	PROJECT MANAGEMENT EXPENSES	0	0	0	0	7,917,168	7,917,168	0.54%
942	FEES, TAXES, AND INSURANCE	0	0	0	0	59,760,000	59,760,000	4.11%
943	SPARE PARTS AND CAPITAL EQUIPMENT	0	0	0	0	37,303,759	37,303,759	2.56%
944	STAFF TRAINING AND STARTUP	0	0	0	0	30,764,824	30,764,824	2.11%
945	GENERAL & ADMINISTRATIVE	0	0	0	0	11,397,863	11,397,863	0.78%
94	OWNER'S COSTS	0	0	0	0	147,143,613	147,143,613	10.11%
9	TOTAL INDIRECT COSTS	165,119,169	62,435,000	18,267,117	0	147,143,613	392,964,899	27.00%
	TOTAL BASE CONSTRUCTION COST	391,113,138	351,646,670	192,573,130	370,703,954	149,143,613	1,455,180,505	100.00%
		26.88%	24.17%	13.23%	25.47%	10.25%	100.00%	

TABLE 4–12
MHTGR–GT/IC PLANT CONTINGENCIES BY ACCOUNT

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	LEAD MODULE		PROTOTYPE		REPLICA		TARGET	
		1992$	%	1992$	%	1992$	%	1992$	%
20	LAND & LAND RIGHTS	300,000	15.0%	300,000	15.0%	300,000	15.0%	300,000	15.0%
211	YARDWORK	1,270,902	18.4%	1,270,902	18.4%	1,255,222	18.4%	1,231,004	18.4%
212	REACTOR COMPLEX	10,646,948	19.9%	26,886,499	20.7%	25,961,977	20.7%	25,550,486	20.7%
213	TURBINE COMPLEX	1,285,013	15.0%	3,412,237	15.0%	3,322,831	15.0%	3,282,503	15.0%
214	OPERATIONS CENTER	667,270	15.0%	667,270	15.0%	661,703	15.0%	653,097	15.0%
215	REMOTE SHUTDOWN BUILDING	28,452	19.0%	28,452	19.0%	28,115	19.0%	27,577	19.0%
216	OTHER BUILDINGS	514,145	15.0%	514,145	15.0%	509,056	15.0%	501,124	15.0%
21	STRUCTURES & IMPROVEMENTS	14,412,730	18.7%	32,779,505	19.5%	31,738,904	19.5%	31,245,791	19.5%
221	REACTOR SYSTEM	14,919,373	28.4%	43,013,064	29.5%	37,208,061	29.7%	33,319,383	29.7%
222	VESSEL SYSTEM	10,641,992	23.7%	37,988,840	23.7%	35,520,296	23.8%	34,116,697	23.9%
223	HEAT TRANSPORT SYSTEM	16,994,369	27.1%	54,286,620	27.2%	47,465,491	27.3%	43,273,983	27.3%
224	SHUTDOWN COOLING SYSTEM	1,653,840	27.8%	4,802,309	27.9%	4,078,005	27.9%	3,746,457	27.9%
225	SHUTDOWN COOLING WATER SYSTEM	244,715	18.0%	904,893	18.0%	843,174	18.0%	791,062	18.0%
226	REACTOR CAVITY COOLING SYSTEM	940,052	19.0%	3,255,742	19.0%	2,945,179	19.0%	2,744,660	19.0%
227	REACTOR SERVICE SYSTEM	10,450,306	22.0%	14,152,060	21.9%	12,772,231	21.8%	11,749,982	21.7%
228	REACTOR CONTROL, PROTECTION & MONITORING	1,267,861	23.9%	3,614,503	24.3%	3,258,461	24.2%	3,000,769	24.2%
229	REACTOR PLANT MISCELLANEOUS	4,257,677	34.3%	4,496,177	32.1%	3,800,803	33.7%	3,492,062	33.3%
22	REACTOR PLANT EQUIPMENT	61,370,185	25.8%	166,514,209	26.1%	147,891,701	26.1%	136,235,055	26.0%
231	TURBINE GENERATOR & AUXILIARIES	6,656,192	24.4%	24,866,006	24.5%	23,249,027	24.5%	21,621,064	24.5%
233	MAIN & AUXILIARY STEAM SYSTEM	468,680	15.0%	1,719,710	15.0%	1,688,693	15.0%	1,676,531	15.0%
234	FEEDWATER & CONDENSATE SYSTEM	6,699,114	15.0%	24,440,439	15.0%	22,412,989	15.0%	20,636,548	15.0%
235	STARTUP & SHUTDOWN SYSTEM	0	0.0%	0	0.0%	0	0.0%	0	0.0%
236	TURBINE PLANT SAMPLING SYSTEM	0	0.0%	0	0.0%	0	0.0%	0	0.0%
237	ECA CONTROL, DATA & INSTRUMENTATION	1,370,942	20.0%	5,237,674	19.9%	5,191,142	19.9%	5,172,014	19.9%
23	TURBINE PLANT EQUIPMENT	15,194,928	18.6%	56,283,829	18.6%	52,541,851	18.7%	49,106,157	18.7%
241	SWITCHGEAR	317,832	15.6%	1,147,923	15.6%	1,133,500	15.6%	1,127,810	15.5%
242	STATION SERVICE EQUIPMENT	1,001,293	19.2%	2,959,924	21.2%	2,934,143	21.1%	2,923,155	21.1%
243	SWITCHBOARDS	155,350	15.1%	618,345	15.1%	616,844	15.1%	616,261	15.1%
244	PROTECTIVE EQUIPMENT	67,223	15.0%	161,340	15.0%	154,322	15.0%	151,152	15.0%
245	ELECTRIC STRUCTURES & WIRING CONTAINERS	1,073,664	25.2%	3,752,960	25.1%	3,484,635	25.1%	3,379,491	25.0%
246	POWER AND CONTROL WIRING	870,795	21.8%	3,113,223	21.5%	2,929,978	21.4%	2,858,169	21.3%
24	ELECTRIC PLANT EQUIPMENT	3,486,157	20.5%	11,753,715	21.0%	11,253,422	20.9%	11,056,038	20.8%

TABLE 4–12
MHTGR–GT/IC PLANT CONTINGENCIES BY ACCOUNT

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	LEAD MODULE		PROTOTYPE		REPLICA		TARGET	
		1992$	%	1992$	%	1992$	%	1992$	%
251	TRANSPORTATION AND LIFT EQUIPMENT	292,014	16.3%	407,740	16.5%	405,187	16.5%	403,389	16.5%
252	AIR, WATER, AND STEAM SERVICE SYSTEM	4,437,239	16.2%	5,155,929	16.1%	5,083,460	16.1%	4,999,513	16.1%
253	COMMUNICATIONS AND SECURITY EQUIPMENT	933,368	21.5%	978,566	21.1%	970,784	21.2%	962,730	21.2%
254	FURNISHINGS AND FIXTURES	476,419	25.0%	476,419	25.0%	475,857	25.0%	475,003	25.0%
25	MISCELLANEOUS PLANT EQUIPMENT	6,139,040	17.3%	7,018,654	17.1%	6,935,288	17.1%	6,840,635	17.1%
261	CIRCULATING AND SERVICE WATER PUMPHOUSE	41,200	15.0%	76,491	15.0%	73,053	15.0%	71,713	15.0%
262	ECA COOLING WATER SYSTEMS	149,043	15.0%	559,073	15.0%	540,699	15.0%	533,497	15.0%
263	CIRCULATING AND SERVICE WATER SYSTEM	970,064	15.0%	2,653,532	15.0%	2,582,050	15.0%	2,553,707	15.0%
26	HEAT REJECTION SYSTEM	1,160,307	15.0%	3,289,096	15.0%	3,195,802	15.0%	3,158,917	15.0%
2	TOTAL DIRECT COSTS	102,063,347	22.3%	277,939,008	22.6%	253,856,968	22.5%	237,942,593	22.4%
911	TEMPORARY CONSTRUCTION FACILITIES	6,447,405	19.7%	12,006,251	20.3%	9,751,983	20.1%	9,530,318	20.1%
912	CONSTRUCTION TOOLS AND EQUIPMENT	4,182,015	18.4%	7,021,596	19.4%	5,869,460	19.1%	5,756,269	19.1%
913	PAYROLL INSURANCE AND TAXES	3,931,518	19.5%	9,494,362	18.6%	8,150,203	18.3%	8,018,147	18.3%
914	PERMITS, INSURANCE, AND LOCAL TAXES	149,626	19.2%	375,942	18.2%	327,936	17.9%	323,220	17.8%
91	CONSTRUCTION SERVICES	14,710,564	19.2%	28,900,150	19.5%	24,099,581	19.2%	23,627,954	19.2%
920	REACTOR MODULE ENGINEERING AND SERVICES	5,411,000	25.0%	13,179,631	25.0%	7,524,581	25.0%	4,566,779	25.0%
921	PLANT ENGINEERING AND SERVICES	19,093,549	23.7%	24,462,309	23.6%	7,990,912	24.2%	7,938,865	24.2%
922	HOME OFFICE QUALITY ASSURANCE	249,868	25.0%	419,077	25.0%	253,364	25.0%	251,629	25.0%
923	HOME OFFICE PROJECT & CONSTRUCTION MGMT.	3,125,190	21.1%	4,802,193	21.9%	2,485,774	23.7%	2,470,159	23.7%
92	ENGINEERING AND HOME OFFICE SERVICES	27,679,607	23.6%	42,863,410	23.9%	18,254,630	24.5%	15,227,432	24.4%
931	FIELD OFFICE EXPENSES	658,826	20.6%	1,505,310	20.3%	1,331,912	20.2%	1,296,768	20.2%
932	FIELD JOB SUPERVISION	3,179,404	19.2%	8,278,361	18.4%	7,597,153	18.2%	7,459,086	18.2%
933	FIELD QUALITY ASSURANCE/QUALITY CONTROL	223,241	21.0%	489,396	21.0%	427,468	21.0%	414,917	21.0%
934	PLANT STARTUP AND TEST	1,169,292	20.9%	2,578,612	20.9%	2,256,586	20.9%	2,191,319	20.9%
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	5,230,763	19.8%	12,851,679	19.2%	11,613,120	19.0%	11,362,093	19.0%
941	PROJECT MANAGEMENT EXPENSES	2,118,925	15.0%	3,295,410	15.0%	1,616,963	15.0%	1,187,575	15.0%
942	FEES, TAXES, AND INSURANCE	1,458,750	15.0%	9,022,500	15.0%	10,282,500	15.0%	8,964,000	15.0%
943	SPARE PARTS AND CAPITAL EQUIPMENT	3,540,027	15.0%	6,011,603	15.0%	5,787,564	15.0%	5,595,564	15.0%
944	STAFF TRAINING AND STARTUP	5,453,233	15.0%	8,592,504	15.0%	7,162,508	15.0%	4,614,724	15.0%
945	GENERAL & ADMINISTRATIVE	1,666,828	15.0%	2,684,928	15.0%	2,160,145	15.0%	1,709,679	15.0%
94	OWNER'S COSTS	14,237,763	15.0%	29,606,945	15.0%	27,009,679	15.1%	22,071,542	15.0%
9	TOTAL INDIRECT COSTS	62,058,697	19.6%	114,222,185	19.3%	80,977,011	18.4%	72,289,021	18.4%
	TOTAL BASE CONSTRUCTION COST	164,122,044	21.2%	392,161,193	21.5%	334,833,979	21.3%	310,231,615	21.3%

TABLE 4–13(a)
MHTGR–GT/IC PROTOTYPE PLANT TOTAL CAPITAL COST COMPARISON

ACCOUNT NUMBER	ACCOUNT NAME	1992 M$ MHTGR GT/IC PLANT	1992 M$ MHTGR SC PLANT	% CHANGE TO GT/IC ESTIMATE	1992 M$ MHTGR GT/DC PLANT	% CHANGE TO GT/IC ESTIMATE
20	LAND & LAND RIGHTS	2.0	2.0	0.0%	2.0	0.0%
21	STRUCTURES & IMPROVEMENTS	167.8	157.4	6.6%	134.7	24.6%
22	REACTOR PLANT EQUIPMENT	638.3	522.9	22.1%	560.7	13.8%
23	TURBINE PLANT EQUIPMENT	302.2	165.2	82.9%	151.1	100.0%
24	ELECTRIC PLANT EQUIPMENT	55.9	54.8	2.0%	55.6	0.5%
25	MISCELLANEOUS PLANT EQUIPMENT	41.0	41.3	−0.7%	31.6	29.7%
26	HEAT REJECTION SYSTEM	21.9	31.2	−29.8%	27.9	−21.5%
2	TOTAL DIRECT COSTS	1,229.1	974.8	26.1%	963.6	27.6%
91	CONSTRUCTION SERVICES	148.5	141.8	4.7%	123.1	20.6%
92	HOME OFFICE ENGINEERING	179.2	176.6	1.5%	189.0	−5.2%
93	FIELD OFFICE ENGINEERING	67.0	63.8	5.0%	53.3	25.7%
94	OWNER'S COSTS	197.4	179.6	9.9%	221.7	−11.0%
9	TOTAL INDIRECT COSTS	592.1	561.8	5.4%	587.1	0.9%
	BASE CONSTRUCTION COSTS	1,821.2	1,536.6	18.5%	1,550.7	17.4%
	– $/KWe –	2,260	2,218	1.9%	1,784	26.6%
	CONTINGENCY	392.1	289.8	35.3%	372.8	5.2%
	OVERNIGHT CONSTRUCTION COSTS	2,213.3	1,826.4	21.2%	1,923.5	15.1%
	– $/KWe –	2,746	2,636	4.2%	2,213	24.1%
	INTEREST DURING CONSTRUCTION	438.2	358.0	22.4%	384.6	13.9%
	TOTAL CAPITAL COST	2,651.5	2,184.4	21.4%	2,308.1	14.9%
	– $/KWe –	3,290	3,153	4.3%	2,656	23.9%

TABLE 4–13(b)
MHTGR–GT/IC REPLICA PLANT TOTAL CAPITAL COST COMPARISON

ACCOUNT NUMBER	ACCOUNT NAME	1992 M$ MHTGR GT/IC PLANT	1992 M$ MHTGR SC PLANT	% CHANGE TO GT/IC ESTIMATE	1992 M$ MHTGR GT/DC PLANT	% CHANGE TO GT/IC ESTIMATE
20	LAND & LAND RIGHTS	2.0	2.0	0.0%	2.0	0.0%
21	STRUCTURES & IMPROVEMENTS	162.6	152.7	6.5%	130.6	24.5%
22	REACTOR PLANT EQUIPMENT	566.8	463.2	22.4%	499.2	13.5%
23	TURBINE PLANT EQUIPMENT	281.6	156.5	79.9%	137.0	105.5%
24	ELECTRIC PLANT EQUIPMENT	53.9	52.8	2.1%	53.7	0.4%
25	MISCELLANEOUS PLANT EQUIPMENT	40.5	40.8	–0.7%	31.2	29.8%
26	HEAT REJECTION SYSTEM	21.3	30.5	–30.2%	27.2	–21.7%
2	TOTAL DIRECT COSTS	1,128.7	898.5	25.6%	880.9	28.1%
91	CONSTRUCTION SERVICES	125.6	119.0	5.5%	100.1	25.5%
92	HOME OFFICE ENGINEERING	74.6	73.0	2.2%	74.3	0.4%
93	FIELD OFFICE ENGINEERING	61.1	58.1	5.2%	47.4	28.9%
94	OWNER'S COSTS	179.0	164.3	8.9%	194.5	–8.0%
9	TOTAL INDIRECT COSTS	440.3	414.4	6.2%	416.3	5.8%
	BASE CONSTRUCTION COSTS	1,569.0	1,312.9	19.5%	1,297.2	21.0%
	– $/KWe –	1,947	1,895	2.7%	1,493	30.4%
	CONTINGENCY	334.8	251.1	33.3%	310.8	7.7%
	OVERNIGHT CONSTRUCTION COSTS	1,903.8	1,564.0	21.7%	1,608.0	18.4%
	– $/KWe –	2,362	2,257	4.6%	1,850	27.6%
	INTEREST DURING CONSTRUCTION	239.7	195.0	22.9%	204.5	17.2%
	TOTAL CAPITAL COST	2,143.5	1,759.0	21.9%	1,812.5	18.3%
	– $/KWe –	2,659	2,539	4.8%	2,086	27.5%

TABLE 4–13(c)
MHTGR–GT/IC TARGET PLANT TOTAL CAPITAL COST COMPARISON

ACCOUNT NUMBER	ACCOUNT NAME	1992 M$ MHTGR GT/IC PLANT	1992 M$ MHTGR SC PLANT	% CHANGE TO GT/IC ESTIMATE	1992 M$ MHTGR GT/DC PLANT	% CHANGE TO GT/IC ESTIMATE
20	LAND & LAND RIGHTS	2.0	2.0	0.0%	2.0	0.0%
21	STRUCTURES & IMPROVEMENTS	160.1	150.1	6.7%	128.5	24.6%
22	REACTOR PLANT EQUIPMENT	523.0	423.2	23.6%	460.4	13.6%
23	TURBINE PLANT EQUIPMENT	263.0	155.7	69.0%	122.7	114.3%
24	ELECTRIC PLANT EQUIPMENT	53.1	51.9	2.3%	53.0	0.2%
25	MISCELLANEOUS PLANT EQUIPMENT	39.9	40.2	−0.7%	30.8	29.5%
26	HEAT REJECTION SYSTEM	21.1	30.2	−30.1%	27.0	−21.9%
2	TOTAL DIRECT COSTS	1,062.2	853.2	24.5%	824.4	28.8%
91	CONSTRUCTION SERVICES	123.4	116.7	5.8%	97.5	26.6%
92	HOME OFFICE ENGINEERING	62.5	59.7	4.7%	62.2	0.5%
93	FIELD OFFICE ENGINEERING	59.9	56.9	5.4%	46.0	30.2%
94	OWNER'S COSTS	147.1	132.0	11.5%	160.6	−8.4%
9	TOTAL INDIRECT COSTS	392.9	365.2	7.6%	366.3	7.3%
	BASE CONSTRUCTION COSTS	1,455.1	1,218.4	19.4%	1,190.7	22.2%
	– $/KWe –	1,805	1,759	2.7%	1,370	31.8%
	CONTINGENCY	310.2	231.9	33.8%	285.4	8.7%
	OVERNIGHT CONSTRUCTION COSTS	1,765.3	1,450.3	21.7%	1,476.1	19.6%
	– $/KWe –	2,190	2,093	4.6%	1,699	28.9%
	INTEREST DURING CONSTRUCTION	215.9	175.6	22.9%	182.3	18.4%
	TOTAL CAPITAL COST	1,981.2	1,625.9	21.8%	1,658.4	19.5%
	– $/KWe –	2,458	2,347	4.7%	1,908	28.8%

SECTION 5

MHTGR-GT/DC CAPITAL COST ESTIMATE RESULTS

The capital cost estimate for the MHTGR-GT/DC was also developed on a differential basis, using the MHTGR-SC as a starting point. However, the degree of extrapolation for the MHTGR-GT/DC is greater than that for the MHTGR-GT/IC, since the technical similarities with the MHTGR-SC are fewer. Relative to the MHTGR-SC, the main circulator, steam generator and the entire steam power conversion system, along with its control system and supporting auxiliary systems (feedwater treatment, etc.) are replaced by a gas turbine and three power conversion heat exchangers, all located within the primary system in a single power conversion pressure vessel. Overall, there is a significant reduction in the number of systems, structures and components, relative to the MHTGR-SC.

As with the MHTGR-GT/IC, the EEDB Code of Accounts was used to structure the MHTGR-GT/DC cost estimate. In doing so, however, some difficulty was encountered in allocating the systems, structures and components of the MHTGR-GT/DC to the various EEDB accounts. For example, the MHTGR-GT/IC power conversion heat exchangers (recuperator, precooler and intercoolers) were allocated to Account 234, which comprises the Feedwater and Condensate System in the MHTGR-SC. This was done since they are located in the secondary system, and serve a similar function to the condenser in the MHTGR-SC. In the case of the MHTGR-GT/DC, however, the power conversion heat exchangers are located in the primary system. In that respect, they may be considered analogous to the steam generator (MHTGR-SC) or IHX (MHTGR-GT/IC). For this reason, these primary system heat exchangers were included in Account 223, Heat Transport System. Given the above caveats, the base construction costs, overnight costs and total capital costs for the Prototype, Replica and Target MHTGR-GT/DC Plants are addressed in the following sections.

5.1 PLANT BASE CONSTRUCTION COSTS

The base construction costs for the MHTGR-GT/DC Prototype Plant Lead Module with common facilities and the completed Prototype, Replica and Target (NOAK) Plants are summarized at the two-digit EEDB cost account level in Tables 5-1(a), 5-1(b), 5-1(c) and 5-1(d), respectively. Additional detail at the three digit cost account level is provided in Appendix C, Tables C-9, C-10, C-11 and C-12, respectively.

Comparison with the prior MHTGR-SC cost estimate reveals the following significant differences by EEDB account for the Target Plants.

Account 21 - Structures and Improvements - Overall, there is a significant decrease (14%) in the structures and improvements account, mostly related to the virtual elimination of the Turbine Complex. The more modest reductions in the Yardwork (211) and Other Buildings (216) accounts also relate to plant simplification. There is a modest offsetting increase in the Reactor Complex (212) account, reflecting an increase in silo diameter to accommodate the larger MHTGR-GT/DC power conversion vessel. However, the MHTGR-

GT/DC silo depth is decreased and reactor building structural and excavation costs are reduced accordingly.

Account 22 - Reactor Plant Equipment - Overall, there is a large increase (9%) in the Reactor Plant Equipment cost, relative to the MHTGR-SC. There are several contributors to this increase. The Reactor System (221) cost increases somewhat, due to materials changes required by the higher reactor operating temperatures. A larger increase is found in the Vessel System account (222). This reflects both the increased size of the power conversion vessel and a materials change from low alloy steel to 9Cr-1Mo-V. The latter is required due to the higher core inlet temperature of the MHTGR-GT/DC. The size of the reactor vessel was also slightly increased. The significant increase in the Heat Transport System (223) cost largely represents the net effect of eliminating the steam generator and main circulator and the addition of the three power conversion loop heat exchangers, noted above. A more modest increase is found in the Reactor Service System (227), based on the additional remote maintenance requirements anticipated for the turbomachine. The Reactor Control, Protection and Monitoring (228) costs also increase, due to the more demanding control and protective requirements of the turbomachine, compared to the MHTGR-SC circulator. A smaller increase is found in the Shutdown Cooling System accounts (224/225), which result from the increased normal operating temperatures of the reactor.

Account 23 - Turbine Plant Equipment - There is a substantial reduction (21%) in the Turbine Plant Equipment category, reflecting the elimination of most MHTGR-SC turbine plant functions. The exception is the Turbine Generator and Auxiliaries (231) account. By analogy with the MHTGR-SC, the MHTGR-GT/DC turbomachine and generator are included in this category. The increased cost of the Turbine Generator and Auxiliaries account, in part, results from the addition of a frequency convertor. The frequency convertor is included for the MHTGR-GT/DC, since the turbomachine optimizes at higher than synchronous speeds to attain the desired high efficiency levels.

Account 24 - Electric Plant Equipment - Overall, there is a modest increase (2%) in the Electric Plant Equipment category. The increase primarily relates to the increased electrical output of the MHTGR-GT/DC, necessitating an increase in the Power and Control Wiring (246) account.

Account 25 - Miscellaneous Plant Equipment - The substantial decrease (23%) found in the Miscellaneous Plant Equipment account reflects the elimination of systems, relative to the MHTGR-SC. The corresponding elimination of requirements for air, water and steam services accounts for most of the reduction.

Account 26 - Heat Rejection System - There is a large reduction (11%) in the Heat Rejection System account, which is largely attributable to the increased efficiency and reduced heat rejection requirements of the MHTGR-GT/DC. The overall reduction is the net effect of a large reduction in the Circulating and Service Water System (263), which is offset by an increase in the ECA Cooling Water Systems (262) account. The latter provides for the isolation cooling loop between the Circulating and Service Water System and the precooler and intercooler, located in the primary system. The isolation cooling loop was selected for the MHTGR-GT/DC to provide improved chemistry control and, hopefully, reduced maintenance for these primary system heat exchangers.

Overall, the total direct costs of the MHTGR-GT/DC Prototype, Replica and Target Plants decrease slightly, by about 1%, 2% and 3%, respectively, relative to the comparable MHTGR-SC plants.

Direct factory equipment costs in the NI represent nearly 34% of the base construction cost for the Lead Module and direct ECA equipment costs represent an additional 3%. The Prototype Plant equipment costs rise as a percentage of total base construction costs to 45% for the NI and 3% for the ECA, primarily due to the common facilities. The MHTGR-GT/DC Target Plant factory equipment percentages change slightly to 48% for NI factory equipment and 4% for the ECA factory equipment primarily due to the application of learning on NI equipment specific to the MHTGR.

Direct site material represents approximately 5 to 7% of total base construction costs for the MHTGR-GT/DC plants. As no learning is applied to the bulk materials, the direct site material cost is identical for the four module Prototype, Replica, and Target Plants while total direct costs decline due to the application of learning. Direct site labor costs as a percentage of total base construction costs are 9% for the Lead Module and the Prototype Plant and increases to 10% for the Replica Plant. The MHTGR-GT/DC Target Plant direct site labor is nearly 16% of total direct cost and 11% of total base construction costs. Direct site materials and labor costs are dramatically reduced for the MHTGR-GT/DC due to the elimination of buildings and equipment associated with the secondary power conversion loop.

Total direct costs as a percentage of base construction costs vary from over 62% on the Lead Module to over 69% on the MHTGR-GT/DC Target Plant. This increase in the direct cost contribution is due to elimination of design efforts required for the Lead Module and the assumption that standardization and certification of the design is successful and multiple MHTGR orders are placed by the vendor team to supplier organizations. As a result, substantial reductions are obtained in home office engineering. Reductions in construction services and field office services are also accomplished, in part due to the reduced field labor hours calculated due to learning. The reactor vendor Home Office Engineering estimates were provided by GA. The remainder of the NI indirects were based on an algorithm developed by BNI and is related primarily to field labor hours, although plant schedule and equipment/material procurement also impact the NI indirects. For the ECA, the BNI algorithm was used with factors appropriate for non-nuclear construction, based on their scope in the ECA. GCRA developed the owner's costs, as documented in Reference 13.

A comparison of the base construction costs and percentage of total plant cost by 3 digit EEDB account for the Prototype, Replica, and Target Plants is given in Table 5-2. Table 5-2 also illustrates the plant to plant account cost reductions due to elimination of FOAK costs and application of learning. A summary of nuclear island, energy conversion area, and total base construction costs by direct and indirect cost categories is given in Table 5-3. Tables 5-2 and 5-3 show that in evolving from the Prototype to the Target Plant, the NI direct costs decline by nearly 16% and the total plant costs decline by more than 23%. The elimination of FOAK costs and learning results in substantial reductions in the indirects between the Prototype and Target Plants. The NI indirects are over 42% lower, the ECA indirects are nearly 52% lower, and owners costs are projected to be nearly 28% lower leading to a 38% reduction in total indirects.

Table 5-2 also shows that the major reductions in the NI costs occur in Account 22, Reactor Plant Equipment, and Account 23, Turbine Plant Equipment, where the turbomachine and auxiliaries are also in the NI. The largest indirect cost reductions occur in Account 92, Home Office Engineering. The reduction in the Reactor Plant Equipment and Turbine Plant Equipment Accounts is attributable to FOAK equipment costs and equipment cost reductions due to learning. The reduction in the indirect costs is attributed to FOAK design costs, standardization and learning.

Table 5-3 also shows that, in evolving from the Prototype to the Target Plant, the ECA direct costs reduce on the order of 2%. This cost reduction is attributed to the improvement in site labor productivity assumed due to the National Labor Alliance and implementation of rolling 4 x 10 schedules for the Target Plant, and to site labor learning. The contribution of site learning is minimal as the ECA contains standard commercial equipment and is constructed in accordance with standard commercial practice. More sizeable reductions occur in the indirect costs. As in the NI, the largest reduction occurs in the Home Office Engineering account which declines by 76%, and is attributable to design standardization and replication and the substantial reduction in ECA scope.

In summary, the 23.2% cost reduction achieved in moving from the Prototype to the Target Plant is comprised of:

- 1.7% due to equipment FOAKs
- 4.4% due to reactor equipment learning
- 2.1% due to turbomachine and other equipment learning
- 0.8% due to construction learning and improvements in productivity
- 3.9% due to owner's cost reduction primarily due to reduced staffing requirements
- 4.0% due to design and licensing indirect account FOAKs
- 6.3% due to learning and design standardization in the indirect accounts

5.1.1 Site Labor Costs

The data in Table 5-3 indicate that direct site labor costs account for between 9% and 11% of the total base construction costs. The percentage rises from the Prototype Plant to the Target Plant because equipment and indirect FOAK costs and equipment learning reduces plant costs at a faster rate than the learning applied to field labor. Overall, direct site labor is a minor contributor to base construction costs. However, the indirect labor cost algorithm used by BNI to estimate NI indirects is also directly related to site labor cost.

Tables 5-4(a), 5-4(b), 5-4(c), and 5-4(d) provide a summary of crew manhours by 2 digit EEDB account for the NI and ECA for the four plant scenarios examined. The MHTGR-GT/DC Lead Module site labor manhours are estimated to be over 2.7 million, of which 2.1 million are associated with NI construction. Relative to the MHTGR-SC Lead Module, the MHTGR-GT/DC site labor manhours savings are dramatic, a 41,000 manhour increase in the NI and an 717,000 reduction in the ECA. For the four module Target Plant, the total site labor manhours increase to over 5.1 million, of which over 4.2 million are related to NI construction. The MHTGR construction activities are heavily weighted

towards structures and improvements relative to other nuclear concepts. Over 45% of the Lead Module and over 47% of the Target Plant manhours are associated with NI structures and improvements. An additional 3 to 6% of total manhours are involved in ECA structures and improvements. Whereas typical nuclear power plants have much more piping, equipment, and electrical installation manhours, the MHTGR is dominated by construction of structures and improvements. This distinctive difference is accentuated for the MHTGR-GT/DC. Historically, there has been less schedule and cost risk associated with installation of concrete and steel for buildings relative to the installation of piping, equipment, and electrical items inside the completed structures.

For the MHTGR-GT/DC Target Plant, nearly 24% of the total manhours involve the electrical crew, 10% the mechanical crew, 14% the piping crew, and 2% for the instrument crew. The instrument crew is newly defined in the 1993 cost estimate update and the manhours reported here would have been reported in prior estimates as electrical crew. Related to structures and improvements, nearly 34% of the total manhours involved the concrete crew, 10% for the structural crew, and over 6% for the engineering crew.

The MHTGR-GT/DC design estimated herein has not yet taken full advantage of the potential for modularization. Structures and improvements dominate the NI cost and limited applications of modularization have been incorporated in the NI design, primarily skid mounted equipment modules. No effort has been undertaken to investigate or incorporate modular design features into the ECA as of this date, even though the potential cost savings and manpower reductions were noted in 1990 in the MHTGR Cost Reduction Report (Reference 5). The MHTGR-GT/DC is recognized to have some further cost reduction potential through modularization although its' potential savings are limited due to the reduced scope of the MHTGR-GT/DC ECA.

Tables 5-5(a), 5-5(b), 5-5(c), and 5-5(d) present the breakdown of site craft labor manhours in a similar format to Tables 5-4(a)-(d) based on the crew mix specified in Table 1-2. All of the cost accounts show reductions in the labor man-hours due to learning in going from the Prototype Plant to the Target Plant.

Tables 5-6(a), 5-6(b), 5-6(c), and 5-6(d) provide a different look at the site craft labor breakdown for the MHTGR-GT/DC Lead Module, Prototype, Replica and Target Plants, respectively. The labor man-hours are summarized by craft at the two-digit account level for each of the plants in for the following crafts: boilermakers, carpenters, electricians, ironworkers, laborers, millwrights, operating engineers, pipefitters, teamsters, and other craft labor. The data in these tables indicate the most highly utilized crafts to be pipefitters and electricians, each accounting for 19% of the total direct labor manhours on the Prototype, Replica and Target Plants. The next most utilized crafts are iron workers at 16%, laborers at 15%, carpenters at 14% and operating engineers at 9%. All of the other crafts combined account for the remaining 8% of craft labor hours on the MHTGR-GT/DC Target Plant.

5.1.2 Factory Equipment and Site Material Costs

Summaries of the factory equipment and site material direct costs by EEDB account for the MHTGR-GT/DC Prototype, Replica and Target (NOAK) Plants are provided in Table 5-3. The factory equipment direct costs account for about 48-52% of the total base construction costs. The site material costs account for about 5-7% of the total base construction costs.

Table 5-3 also shows that nuclear island factory equipment costs amount to nearly 48% of total base construction costs for the Target Plant, nearly 70% of which is contained in Account 22, Reactor Plant Equipment. The second most significant NI factory equipment account is the Turbine Plant Equipment, Account 23, which contains nearly 20% of the total factory equipment costs and 10% of total base construction costs. The helium turbomachine and auxiliary equipment is included in the Nuclear Island, Account 23, unlike the MHTGR-SC and MHTGR-GT/IC where the turbomachine and auxiliaries are included in the ECA.

The only factory equipment accounts which contain any reductions in costs in evolving from the Lead to the Target Plant are Reactor Plant Equipment, Account 22 and the Turbine Plant Equipment, Account 23. Table 5-7 details the major reactor plant equipment items included in the reactor manufacturer scope and the turbomachine and related equipment has also been included. Table 5-7 itemizes the learning factor applied, factory FOAK costs, and equipment cost details for the Lead Module, Prototype, Replica, and Target Plant. Learning is applied at the 94% factory equipment guideline for all reactor equipment, except the reactor and power conversion vessels, precoolers and intercoolers, and equipment transportation costs. No learning is applied to the equipment transportation costs. A 98% learning factor is applied to the vessels and a 96% learning factor was applied to the heat exchangers to recover facility capital costs over a 12 year operating life, the production of 44 units. The 12 year recovery period is projected to be conservative relative to other reactor plant equipment and yields substantially higher Target Plant equipment costs relative to the default 94% learning curve offered in the guidelines. Changing the vessels from 96% to 98% increased Target Plant direct costs by $11 million. The direct cost impact of changing the heat exchanger learning factor from 94% to 96% was a $3 million increase. The more conservative learning factors applied to the vessels and heat exchangers result in a $35 million increase in MHTGR-GT/DC overnight costs (a 2% increase). The Reactor Plant Equipment Account also contains equipment FOAK costs of $25.1 million, excluding contingency. FOAK design, tooling and setup costs of $0.5 million have been included in the MHTGR-GT/DC Lead Module turbomachine costs. No reductions in cost occur in the other factory equipment accounts as the equipment is assumed to be commercially available.

Table 5-3 also shows that NI site materials cost comprise 4-6% of total base construction costs and the ECA site materials comprise about 1% of total base construction costs. Over 60% of the direct site material costs are associated with NI structures and improvements and less than 1% associated with ECA structures and improvements. No learning factors are applied to site materials.

To permit comparison on a bulk basis of selected site materials (i.e., commodities) with alternative plants, bulk commodity data are given in Table 5-8 for the MHTGR-GT/DC

Lead Module and in Table 5-9 for the MHTGR-GT/DC Target Plant. The Prototype and Replica Plants have the same quantities as the Target Plant. The data in Tables 5-8 and 5-9 are provided by 2-digit EEDB Account for the NI, ECA and total plant. The structural materials identified in Tables 5-8 and 5-9 are assumed to be non-nuclear for the purposes of costing consistent with the ACI 318 construction code approach. As the NI structures are only required to maintain their structural integrity and are not designed to maintain a pressure boundary, the lower non-nuclear costs are appropriate. Other materials in the NI are nuclear grade, and carry the higher nuclear commodity prices and installation manhour rates.

5.1.3 Indirect Costs

The indirect cost estimates were developed by BNI, GA, and GCRA. GA estimated the reactor module engineering & services, Account 920, covering indirect costs associated with supply of the reactor plant equipment. The indirect costs for the NI design and construction were based on the algorithm prepared by Bechtel as presented in Section 3.1.3. The indirect costs for the ECA design and construction were based on the same Bechtel algorithm for nuclear construction. As the power conversion equipment is included in the nuclear island, separated construction and indirects is viewed as undesirable and unnecessary for the MHTGR-GT/DC Plant design. Hence the Bechtel algorithm for nuclear construction has been applied to the entire plant scope. GCRA prepared the owner's cost estimate, Account 94.

FOAK indirect costs to support the Lead Module design and construction were estimated to be $6 million for the reactor manufacturer's scope, $40 million for the NI design and construction scope, and $15 million for the ECA design and construction scope. These FOAK costs are costs incurred over and above the standard design and licensing costs and cover completion of system and structural designs beyond that required for licensing and the FDA, preparation of procurement specifications, construction and fabrication drawings, construction procedures and sequencing, startup procedures, and other details required for construction. Construction of following reactor modules would use this information directly due to the standardized, replicated design.

Recurring MHTGR RM indirects were estimated by GA to be nearly $16 million per module with a 76% learning curve, the same as the MHTGR-SC and MHTGR-GT/IC. The RM indirects for the Prototype Plant were estimated to be nearly $47 million. Due to replication of the standardized, certified design and the streamlined Target Plant construction schedule, the Target Plant RM indirects were estimated to fall to $18 million. Recurring RM indirects were estimated to be 8% of total RM equipment direct costs for the Prototype Plant and 3.5% for the Target Plant. These reductions in cost are realizable only if the groundrule assumptions hold, that is, no changes in regulations or design and no funding restrictions during construction.

Recurring architect engineering indirects were estimated by BNI and included support to obtain site specific permits and licenses, as described in Section 3.1.3. The total recurring indirects were estimated by the adjusted algorithm to be $148 million for the Lead Module, over 39% of total direct costs. Application of field learning and the shortened construction schedule led to reductions in recurring NI indirects in following

commercial plants. The estimated recurring NI indirects were $257, $192, and $187 million for the Prototype, Replica, and Target Plants, respectively.

The Reference 3 DOE cost estimating guidelines encourage a detailed, task related estimate. Because of the aforementioned difficulties in relating historical experience with the groundrule scenario and providing supportable, technology related adjustments, a high priority should be placed on developing the scope of work contained in all the indirects and their corresponding costs in the next overall cost estimate update effort. This effort should address both FOAK and recurring costs under the guidelines, especially as these costs may be related to historical experience on one-of-a-kind LWR plant designs.

The Owner's costs (Account 94) in the MHTGR base construction cost estimates were developed on a bottom-up basis, Reference 13, and a summary of the results is given in Table 5-10. These results indicate that the owner's cost could range from nearly 17% of the other direct and indirect costs for the Prototype Plant to over 15% of the other direct and indirect costs for the Target Plant. A major factor in the increased relative owner's cost is the assumption the a spare turbomachine and recuperator module have been added to the MHTGR-GT/DC spare parts allotment. The spare turbomachine and recuperator module adds $40 million to the Lead Module and Prototype Plant, $36 million to the Replica Plant, and $31 million to the Target Plant base construction cost. The potential to share spare turbomachines between MHTGR sites might be considered to reduce owner's costs if the penalty on plant capacity factor can be minimized. The availability of the spare turbomachine permits reductions in the allotted time for turbomachine outages in the MHTGR-GT/DC concept which leads to a higher availability estimate for the MHTGR-GT/DC relative to the MHTGR-SC design.

5.1.4 Summary of MHTGR-GT/DC Base Construction Costs

Table 5-11 provides a breakdown of MHTGR-GT/DC Target Plant base construction costs at the three digit level by cost estimating organization. Note that Bechtel provided both the NI and ECA inputs, but used the SWEC input for the MHTGR-GT/IC where applicable. Additional detail is provided for the reactor complex buildings, Account 212. The percentage contribution of each cost account to the total base construction costs is also noted together with the percentage by estimator. For the MHTGR-GT/DC, 69% of the total base construction cost is direct cost and 31% is estimated to be indirect costs. Reactor Plant Equipment, Account 22, represents nearly 39% of the total base construction costs. Structures and Improvements, Account 21, at 11%, and Turbine Plant Equipment, Account 23, at 10%, are the next largest contributors to MHTGR-GT/DC Target Plant capital cost. Land and owner's costs are estimated to be nearly 14% OF MHTGR-GT/DC base construction cost.

MHTGR-GT/DC Target Plant base construction costs are estimated to be $1,191 million. Tables 5-1, 5-2, and 5-3 identify total base construction costs for the four MHTGR-GT/DC plant scenarios estimated. Total base construction costs for the Lead Module, Prototype and Replica Plants are $741, $1,551, and $1,297 million, respectively.

5.2 OVERNIGHT CONSTRUCTION COSTS

Overnight construction costs are obtained by adding contingency to the base construction costs. The MHTGR-GT/DC cost estimate is based on nearly 1400 line item entries defining equipment, systems, bulk commodities, with their associated quantities, unit costs and installation manhours. Each of these line items carries a contingency factor to achieve a 50% confidence estimate. Table 5-12 provides a breakdown of MHTGR-GT/DC contingency costs by three digit cost account for the Lead Module, Prototype, Replica, and Target Plants. These costs were calculated by summing all the individual line item contingencies, and the percentages were calculated by dividing the total account contingency by the account base construction cost. The total contingency estimated for the MHTGR-GT/DC Lead Module is $168 million or 22.7% of total base construction costs. The MHTGR-GT/DC Target Plant contingency is estimated to be $285 million or 24.0% of total base construction costs.

The Reference 3 Guidelines specified a default contingency of 25% for nuclear and 15% for conventional construction items and allows insertion of different contingencies, if justified. Many of the ECA accounts show the default 15% contingency and most other accounts have a contingency between 15% and 25% due to the combination of nuclear and conventional construction items. Major primary system components including the reactor vessel were assigned a 25% contingency. The power conversion vessel, metallic reactor internals, vessel supports, heat transport system internals, and turbomachine were assigned a 35% contingency. The shutdown cooling heat exchanger was assigned a 30% contingency and the precooler/intercooler was assigned a 20% contingency. A 15% contingency based on ABB/CENP's experience with large nuclear class vessels for LWR's was assigned to the pressure relief and transportation accounts. A 25% contingency was applied to all reactor system components and the reactor service equipment received a much higher contingency (32-34%) due to perceived uncertainties in the scope of the estimate. The average contingency percentage on each account varies slightly from plant to plant in Table 5-12 due to the learning applied and the line item contingencies assigned. The contingency applied in this table does not include an allowance for indeterminates, which is already included in the base construction cost estimate.

5.3 TOTAL CAPITAL COSTS

The cost of invested capital is added to the overnight capital costs to account for estimated plant cash flows and the time value of money. Allowance for funds used during construction (AFUDC) includes the interest paid on debt and preferred stock and a return on investment for common stock. The cost of money identified in Table 1-6 is used to calculate interest during construction. The methodology for calculating interest during construction (IDC) is specified in References 2 and 3. Based on an assumed utility financial structure, the average cost of money before taxes is 11.35%, or 6.05% real (inflation-adjusted).

Table 5-13(a), 5-13(b), and 5-13(c) summarize the Prototype, Replica, and Target Plant capital cost estimates, respectively, including capital cost estimate breakdown at the 2 digit account level, contingency, and interest during construction. In addition, these

tables provide a comparison with the MHTGR-SC and MHTGR-GT/IC plant cost estimates at the 2 digit level. The percentage increase or decrease of the MHTGR-GT/DC cost estimate relative to the MHTGR-SC and MHTGR-GT/IC cost estimates is also included for information. Based on adjustments to the MHTGR-SC quarterly cash flows provided in Table 3-14, the interest during construction is estimated to be $402 million for the Prototype Plant, $205 million for the Replica Plant, and $182 million for the Target Plant. Interest during construction costs for the Prototype Plant were calculated using the utility financial structure and average cost of money presented in Table 1-6. It should be noted that the Reference MHTGR-GT/DC deployment scenario assumes government ownership of the Lead Module and interest during construction on the Lead Module would not be ordinarily included on a government project. For the purposes of consistency the Lead Module interest during construction was included in the Prototype Plant as if all four modules were constructed by an investor owned utility with the Table 1-6 financial structure. The resultant total capital cost estimates for the MHTGR-GT/DC Prototype Plant is $2,308 million or $2,656/kW. The Replica Plant total capital plant cost is reduced to $1,812 million or $2,086/kW resulting from elimination of Lead Module design and factory FOAKs, reductions in the overall construction schedule, and the impact of learning on MHTGR specific equipment and field installation labor. For the MHTGR-GT/DC Target Plant, representing the 21st through 24th reactor modules, total capital costs are estimated to be $1,658 million or $1,908/kW. The Target Plant cost reductions are achieved through additional learning on factory fabricated equipment and field installation labor.

The MHTGR-GT/DC Target Plant, though 2% higher in total capital costs is nearly 19% less expensive in terms of $/kW due to the increased output of the higher efficiency gas turbomachine. The MHTGR-GT/DC is 16% less expensive than the MHTGR-GT/IC and 22% less expensive in unit capital cost. The inclusion of the spare turbomachine in the owner's costs for the MHTGR-GT/DC increases total capital costs for the Target Plant by more than 2%. The spare turbomachine is included so that remote maintenance may be performed without substantial penalties in unit availability/capacity factor. However, it should be noted that the MHTGR-GT/DC is evaluated to be capable of a 89% capacity factor, significantly higher than the 86% availability/capacity factor estimated for the MHTGR-SC.

TABLE 5-1(a)
MHTGR-GT/DC LEAD MODULE BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
21	STRUCTURES & IMPROVEMENTS	3,755,500	1,242,369	30,182,052	22,341,978	56,279,530	4,100,549	163,855	4,195,320	759,365	9,055,234	65,334,764
22	REACTOR PLANT EQUIPMENT	200,996,150	344,065	8,698,138	3,712,624	213,406,912	966,700	23,765	599,354	128,500	1,694,554	215,101,466
23	TURBINE PLANT EQUIPMENT	40,312,000	5,480	145,822	44,000	40,501,822	2,145,000	8,483	220,028	46,780	2,411,808	42,913,630
24	ELECTRIC PLANT EQUIPMENT	1,527,150	227,494	6,130,965	957,286	8,615,401	9,537,300	64,934	1,742,591	8,400	11,288,291	19,903,692
25	MISCELLANEOUS PLANT EQUIPMENT	1,973,800	292,796	7,334,458	4,355,273	13,663,531	4,613,900	208,479	5,142,711	3,548,785	13,305,396	26,968,927
26	HEAT REJECTION SYSTEM	0	0	0	0	0	3,875,000	123,379	3,073,147	1,458,653	8,406,800	8,406,800
2	TOTAL DIRECT COSTS	248,564,600	2,112,204	52,491,435	31,411,161	332,467,196	25,238,449	592,895	14,973,151	7,950,483	48,162,083	380,629,279
91	CONSTRUCTION SERVICES	0	0	41,695,390	17,869,453	59,564,843	0	0	6,498,348	2,785,006	9,283,354	68,848,196
92	ENGINEERING AND HOME OFFICE SERVICES	21,644,000	0	82,367,152	0	104,011,152	0	0	23,701,970	0	23,701,970	127,713,122
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	20,298,025	3,866,290	24,164,315	0	0	4,150,557	790,582	4,941,140	29,105,455
94	OWNER'S COSTS	0	0	0	0	0	0	0	53,926,779	80,924,908	134,851,687	134,851,687
9	TOTAL INDIRECT COSTS	21,644,000	0	144,360,567	21,735,743	187,740,310	0	0	88,277,654	84,500,496	172,778,150	360,518,460
	TOTAL BASE CONSTRUCTION COST	270,208,600	2,112,204	196,852,002	53,146,904	520,207,506	25,238,449	592,895	103,250,805	92,450,979	220,940,233	741,147,739

TABLE 5-1(b)
MHTGR-GT/DC PROTOTYPE PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
21	STRUCTURES & IMPROVEMENTS	12,268,000	2,684,396	65,110,412	48,251,789	125,630,201	4,100,549	163,855	4,195,320	759,365	9,055,234	134,685,435
22	REACTOR PLANT EQUIPMENT	527,949,409	873,831	22,167,107	8,908,819	559,025,335	966,700	23,765	599,354	128,500	1,694,554	560,719,889
23	TURBINE PLANT EQUIPMENT	148,460,099	5,480	145,822	44,000	148,649,921	2,145,000	8,483	220,028	46,780	2,411,808	151,061,729
24	ELECTRIC PLANT EQUIPMENT	6,108,600	791,086	21,319,766	3,829,144	31,257,510	19,589,400	177,655	4,780,418	8,400	24,378,218	55,635,728
25	MISCELLANEOUS PLANT EQUIPMENT	3,265,840	326,373	8,162,094	5,705,063	17,132,997	5,213,900	225,357	5,564,260	3,701,335	14,479,495	31,612,492
26	HEAT REJECTION SYSTEM	0	0	0	0	0	13,160,000	361,251	9,033,867	5,671,406	27,865,273	27,865,273
2	TOTAL DIRECT COSTS	698,051,948	4,681,166	116,905,201	66,738,815	881,695,964	45,175,549	960,366	24,393,247	12,315,786	81,884,582	963,580,546
91	CONSTRUCTION SERVICES	0	0	75,562,815	32,384,064	107,946,878	0	0	10,586,669	4,537,144	15,123,813	123,070,691
92	ENGINEERING AND HOME OFFICE SERVICES	52,719,324	0	106,638,517	0	159,357,841	0	0	29,610,965	0	29,610,965	188,968,806
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	38,028,284	7,243,483	45,271,767	0	0	6,761,808	1,287,963	8,049,772	53,321,539
94	OWNER'S COSTS	0	0	0	0	0	0	0	77,758,202	143,957,195	221,715,397	221,715,397
9	TOTAL INDIRECT COSTS	52,719,324	0	220,229,616	39,627,546	312,576,487	0	0	124,717,644	149,782,303	274,499,947	587,076,433
	TOTAL BASE CONSTRUCTION COST	750,771,271	4,681,166	337,134,817	106,366,361	1,194,272,450	45,175,549	960,366	149,110,891	162,098,089	356,384,529	1,550,656,979

TABLE 5-1(c)
MHTGR-GT/DC REPLICA PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
21	STRUCTURES & IMPROVEMENTS	12,268,000	2,517,714	61,070,402	48,251,789	121,590,191	4,100,549	160,583	4,111,540	759,365	8,971,454	130,561,645
22	REACTOR PLANT EQUIPMENT	467,929,904	814,948	20,671,314	8,908,819	497,510,037	966,700	23,289	587,349	128,500	1,682,549	499,192,586
23	TURBINE PLANT EQUIPMENT	134,424,328	5,370	142,896	44,000	134,611,224	2,145,000	8,313	215,619	46,780	2,407,399	137,018,623
24	ELECTRIC PLANT EQUIPMENT	6,108,600	732,197	19,732,711	3,829,144	29,670,455	19,589,400	165,486	4,452,614	8,400	24,050,414	53,720,869
25	MISCELLANEOUS PLANT EQUIPMENT	3,259,960	317,280	7,935,610	5,705,063	16,900,633	5,213,900	219,563	5,420,836	3,701,335	14,336,071	31,236,704
26	HEAT REJECTION SYSTEM	0	0	0	0	0	13,160,000	335,600	8,391,797	5,671,406	27,223,203	27,223,203
2	TOTAL DIRECT COSTS	623,990,792	4,387,509	109,552,933	66,738,815	800,282,540	45,175,549	912,834	23,179,755	12,315,786	80,671,090	880,953,630
91	CONSTRUCTION SERVICES	0	0	60,021,575	25,723,532	85,745,107	0	0	10,060,014	4,311,434	14,371,448	100,116,555
92	ENGINEERING AND HOME OFFICE SERVICES	30,098,323	0	40,188,917	0	70,287,240	0	0	4,030,438	0	4,030,438	74,317,677
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	33,368,273	6,355,861	39,724,134	0	0	6,425,428	1,223,891	7,649,319	47,373,453
94	OWNER'S COSTS	0	0	0	0	0	0	0	54,844,846	139,630,384	194,475,229	194,475,229
9	TOTAL INDIRECT COSTS	30,098,323	0	133,578,765	32,079,394	195,756,481	0	0	75,360,725	145,165,709	220,526,434	416,282,915
	TOTAL BASE CONSTRUCTION COST	654,089,115	4,387,509	243,131,698	98,818,209	996,039,021	45,175,549	912,834	98,540,480	157,481,495	301,197,524	1,297,236,545

TABLE 5-1(d)
MHTGR-GT/DC TARGET PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
21	STRUCTURES & IMPROVEMENTS	12,268,000	2,438,358	59,145,548	48,251,789	119,665,337	4,100,549	155,514	3,981,764	759,365	8,841,678	128,507,015
22	REACTOR PLANT EQUIPMENT	429,804,521	789,273	20,020,045	8,908,819	458,733,385	966,700	22,554	568,812	128,500	1,664,012	460,397,397
23	TURBINE PLANT EQUIPMENT	120,159,249	5,202	138,425	44,000	120,341,674	2,145,000	8,052	208,846	46,780	2,400,626	122,742,300
24	ELECTRIC PLANT EQUIPMENT	6,108,600	709,121	19,110,810	3,829,144	29,048,554	19,589,400	160,269	4,312,245	8,400	23,910,045	52,958,599
25	MISCELLANEOUS PLANT EQUIPMENT	3,251,354	307,284	7,685,605	5,705,063	16,642,022	5,213,900	212,636	5,249,815	3,701,335	14,165,050	30,807,072
26	HEAT REJECTION SYSTEM	0	0	0	0	0	13,160,000	325,028	8,127,431	5,671,406	26,958,837	26,958,837
2	TOTAL DIRECT COSTS	571,591,724	4,249,238	106,100,433	66,738,815	744,430,972	45,175,549	884,053	22,448,913	12,315,786	79,940,248	824,371,220
91	CONSTRUCTION SERVICES	0	0	58,490,165	25,067,213	83,557,378	0	0	9,742,828	4,175,498	13,918,326	97,475,704
92	ENGINEERING AND HOME OFFICE SERVICES	18,267,117	0	39,918,514	0	58,185,631	0	0	3,974,432	0	3,974,432	62,160,063
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	32,390,146	6,169,552	38,559,698	0	0	6,222,839	1,185,303	7,408,141	45,967,839
94	OWNER'S COSTS	0	0	0	0	0	0	0	37,280,104	123,291,322	160,571,427	160,571,427
9	TOTAL INDIRECT COSTS	18,267,117	0	130,798,825	31,236,765	180,302,707	0	0	57,220,203	128,652,123	185,872,326	366,175,033
	TOTAL BASE CONSTRUCTION COST	589,858,841	4,249,238	236,899,258	97,975,580	924,733,679	45,175,549	884,053	79,669,116	140,967,909	265,812,574	1,190,546,253

TABLE 5–2
MHTGR–GT/DC PLANT COSTS AND % BY ACCOUNT

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE								% CHANGE	
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	PROTOTYPE 1992$	PROTOTYPE %	REPLICA 1992$	REPLICA %	TARGET 1992$	TARGET %	PROTOTYPE TO TARGET	REPLICA TO TARGET
20	LAND & LAND RIGHTS	2,000,000	0.1%	2,000,000	0.2%	2,000,000	0.2%	0.0%	0.0%
211	YARDWORK	4,533,371	0.3%	4,473,276	0.3%	4,380,413	0.4%	−3.4%	−2.1%
212	REACTOR COMPLEX	119,990,669	7.7%	116,017,308	8.9%	114,195,633	9.6%	−4.8%	−1.6%
213	TURBINE COMPLEX	2,446,188	0.2%	2,421,083	0.2%	2,382,111	0.2%	−2.6%	−1.6%
214	OPERATIONS CENTER	4,435,757	0.3%	4,398,098	0.3%	4,339,885	0.4%	−2.2%	−1.3%
215	REMOTE SHUTDOWN BUILDING	149,750	0.0%	147,965	0.0%	145,137	0.0%	−3.1%	−1.9%
216	OTHER BUILDINGS	3,129,700	0.2%	3,103,915	0.2%	3,063,836	0.3%	−2.1%	−1.3%
21	STRUCTURES & IMPROVEMENTS	134,685,435	8.7%	130,561,645	10.1%	128,507,015	10.8%	−4.6%	−1.6%
221	REACTOR SYSTEM	146,039,998	9.4%	125,305,855	9.7%	112,252,935	9.4%	−23.1%	−10.4%
222	VESSEL SYSTEM	163,204,375	10.5%	152,243,540	11.7%	145,651,060	12.2%	−10.8%	−4.3%
223	HEAT TRANSPORT SYSTEM	119,964,582	7.7%	105,519,631	8.1%	95,522,392	8.0%	−20.4%	−9.5%
224	SHUTDOWN COOLING SYSTEM	17,222,576	1.1%	14,619,796	1.1%	13,411,925	1.1%	−22.1%	−8.3%
225	SHUTDOWN COOLING WATER SYSTEM	4,303,690	0.3%	3,983,767	0.3%	3,703,397	0.3%	−13.9%	−7.0%
226	REACTOR CAVITY COOLING SYSTEM	17,135,490	1.1%	15,500,944	1.2%	14,445,579	1.2%	−15.7%	−6.8%
227	REACTOR SERVICE SYSTEM	61,979,256	4.0%	55,984,426	4.3%	51,283,978	4.3%	−17.3%	−8.4%
228	REACTOR CONTROL, PROTECTION & MONITORING	16,852,822	1.1%	14,742,629	1.1%	13,629,362	1.1%	−19.1%	−7.6%
229	REACTOR PLANT MISCELLANEOUS	14,017,100	0.9%	11,291,998	0.9%	10,496,770	0.9%	−25.1%	−7.0%
22	REACTOR PLANT EQUIPMENT	560,719,889	36.2%	499,192,586	38.5%	460,397,397	38.7%	−17.9%	−7.8%
231	TURBINE GENERATOR & AUXILIARIES	145,790,716	9.4%	132,020,685	10.2%	118,008,683	9.9%	−19.1%	−10.6%
233	MAIN & AUXILIARY STEAM SYSTEM	260,794	0.0%	259,073	0.0%	256,451	0.0%	−1.7%	−1.0%
234	FEEDWATER & CONDENSATE SYSTEM	0	0.0%	0	0.0%	0	0.0%	0.0%	0.0%
235	STARTUP & SHUTDOWN SYSTEM	0	0.0%	0	0.0%	0	0.0%	0.0%	0.0%
236	TURBINE PLANT SAMPLING SYSTEM	0	0.0%	0	0.0%	0	0.0%	0.0%	0.0%
237	ECA CONTROL, DATA & INSTRUMENTATION	5,010,219	0.3%	4,738,865	0.4%	4,477,165	0.4%	−10.6%	−5.5%
23	TURBINE PLANT EQUIPMENT	151,061,729	9.7%	137,018,623	10.6%	122,742,300	10.3%	−18.7%	−10.4%
241	SWITCHGEAR	6,951,995	0.4%	6,876,454	0.5%	6,846,243	0.6%	−1.5%	−0.4%
242	STATION SERVICE EQUIPMENT	13,245,821	0.9%	13,138,713	1.0%	13,090,806	1.1%	−1.2%	−0.4%
243	SWITCHBOARDS	3,708,710	0.2%	3,704,859	0.3%	3,700,735	0.3%	−0.2%	−0.1%
244	PROTECTIVE EQUIPMENT	672,655	0.0%	647,671	0.0%	635,085	0.1%	−5.6%	−1.9%
245	ELECTRIC STRUCTURES & WIRING CONTAINERS	13,697,144	0.9%	12,728,212	1.0%	12,348,514	1.0%	−9.8%	−3.0%
246	POWER AND CONTROL WIRING	17,359,403	1.1%	16,624,960	1.3%	16,337,216	1.4%	−5.9%	−1.7%
24	ELECTRIC PLANT EQUIPMENT	55,635,728	3.6%	53,720,869	4.1%	52,958,599	4.4%	−4.8%	−1.4%

TABLE 5-2
MHTGR-GT/DC PLANT COSTS AND % BY ACCOUNT

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE								% CHANGE	
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	PROTOTYPE 1992$	PROTOTYPE %	REPLICA 1992$	REPLICA %	TARGET 1992$	TARGET %	PROTOTYPE TO TARGET	REPLICA TO TARGET
251	TRANSPORTATION AND LIFT EQUIPMENT	2,156,748	0.1%	2,142,239	0.2%	2,132,434	0.2%	-1.1%	-0.5%
252	AIR, WATER, AND STEAM SERVICE SYSTEM	23,316,883	1.5%	22,982,899	1.8%	22,605,319	1.9%	-3.1%	-1.6%
253	COMMUNICATIONS AND SECURITY EQUIPMENT	4,234,686	0.3%	4,210,155	0.3%	4,172,168	0.4%	-1.5%	-0.9%
254	FURNISHINGS AND FIXTURES	1,904,175	0.1%	1,901,411	0.1%	1,897,151	0.2%	-0.4%	-0.2%
25	MISCELLANEOUS PLANT EQUIPMENT	31,612,492	2.0%	31,236,704	2.4%	30,807,072	2.6%	-2.5%	-1.4%
261	CIRCULATING AND SERVICE WATER PUMPHOUSE	442,151	0.0%	421,362	0.0%	413,243	0.0%	-6.5%	-1.9%
262	ECA COOLING WATER SYSTEMS	10,232,795	0.7%	10,147,946	0.8%	10,102,942	0.8%	-1.3%	-0.4%
263	CIRCULATING AND SERVICE WATER SYSTEM	17,190,327	1.1%	16,653,895	1.3%	16,442,652	1.4%	-4.3%	-1.3%
26	HEAT REJECTION SYSTEM	27,865,273	1.8%	27,223,203	2.1%	26,958,837	2.3%	-3.3%	-1.0%
2	TOTAL DIRECT COSTS	963,580,546	62.1%	880,953,630	67.9%	824,371,220	69.2%	-14.4%	-6.4%
911	TEMPORARY CONSTRUCTION FACILITIES	57,843,225	3.7%	47,054,781	3.6%	45,813,581	3.8%	-20.8%	-2.6%
912	CONSTRUCTION TOOLS AND EQUIPMENT	29,536,966	1.9%	24,027,973	1.9%	23,394,169	2.0%	-20.8%	-2.6%
913	PAYROLL INSURANCE AND TAXES	34,459,794	2.2%	28,032,635	2.2%	27,293,197	2.3%	-20.8%	-2.6%
914	PERMITS, INSURANCE, AND LOCAL TAXES	1,230,707	0.1%	1,001,166	0.1%	974,757	0.1%	-20.8%	-2.6%
91	CONSTRUCTION SERVICES	123,070,691	7.9%	100,116,555	7.7%	97,475,704	8.2%	-20.8%	-2.6%
920	REACTOR MODULE ENGINEERING AND SERVICES	52,719,324	3.4%	30,098,323	2.3%	18,267,117	1.5%	-65.4%	-39.3%
921	PLANT ENGINEERING AND SERVICES	110,562,112	7.1%	33,164,516	2.6%	32,919,709	2.8%	-70.2%	-0.7%
922	HOME OFFICE QUALITY ASSURANCE	2,018,737	0.1%	1,105,484	0.1%	1,097,324	0.1%	-45.6%	-0.7%
923	HOME OFFICE PROJECT & CONSTRUCTION MGMT.	23,668,634	1.5%	9,949,355	0.8%	9,875,913	0.8%	-58.3%	-0.7%
92	ENGINEERING AND HOME OFFICE SERVICES	188,968,806	12.2%	74,317,677	5.7%	62,160,063	5.2%	-67.1%	-16.4%
931	FIELD OFFICE EXPENSES	7,465,015	0.5%	6,632,283	0.5%	6,435,497	0.5%	-13.8%	-3.0%
932	FIELD JOB SUPERVISION	29,326,846	1.9%	26,055,399	2.0%	25,282,312	2.1%	-13.8%	-3.0%
933	FIELD QUALITY ASSURANCE/QUALITY CONTROL	2,666,077	0.2%	2,368,673	0.2%	2,298,392	0.2%	-13.8%	-3.0%
934	PLANT STARTUP AND TEST	13,863,600	0.9%	12,317,098	0.9%	11,951,638	1.0%	-13.8%	-3.0%
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	53,321,539	3.4%	47,373,453	3.7%	45,967,839	3.9%	-13.8%	-3.0%
941	PROJECT MANAGEMENT EXPENSES	22,282,796	1.4%	10,020,401	0.8%	8,233,510	0.7%	-63.0%	-17.8%
942	FEES, TAXES, AND INSURANCE	55,650,000	3.6%	57,800,000	4.5%	50,010,000	4.2%	-10.1%	-13.5%
943	SPARE PARTS AND CAPITAL EQUIPMENT	70,642,938	4.6%	65,745,684	5.1%	59,654,256	5.0%	-15.6%	-9.3%
944	STAFF TRAINING AND STARTUP	51,478,959	3.3%	43,081,940	3.3%	28,252,605	2.4%	-45.1%	-34.4%
945	GENERAL & ADMINISTRATIVE	21,660,704	1.4%	17,827,204	1.4%	14,421,056	1.2%	-33.4%	-19.1%
94	OWNER'S COSTS	221,715,397	14.3%	194,475,229	15.0%	160,571,427	13.5%	-27.6%	-17.4%
9	TOTAL INDIRECT COSTS	587,076,433	37.9%	416,282,915	32.1%	366,175,033	30.8%	-37.6%	-12.0%
	TOTAL BASE CONSTRUCTION COST	1,550,656,979	100.0%	1,297,236,545	100.0%	1,190,546,253	100.0%	-23.2%	-8.2%

TABLE 5–3
SUMMARY MHTGR–GT/DC COSTS BY COST CATEGORY

COST CATEGORY	PROTOTYPE COST	PROTOTYPE % OF TOTAL	REPLICA COST	REPLICA % OF TOTAL	TARGET COST	TARGET % OF TOTAL	% CHANGE PROTOTYPE TO TARGET	% CHANGE REPLICA TO TARGET
NUCLEAR ISLAND (NI)								
FACTORY EQUIPMENT	698,051,948	45.0%	623,990,792	48.1%	571,591,724	48.0%	-18.1%	-8.4%
SITE LABOR COST	116,905,201	7.5%	109,552,933	8.4%	106,100,433	8.9%	-9.2%	-3.2%
SITE MATERIAL	66,738,815	4.3%	66,738,815	5.1%	66,738,815	5.6%	0.0%	0.0%
TOTAL NI DIRECT COST	881,695,964	56.9%	800,282,540	61.7%	744,430,972	62.5%	-15.6%	-7.0%
CONSTRUCTION SERVICES	107,946,878	7.0%	85,745,107	6.6%	83,557,378	7.0%	-22.6%	-2.6%
HOME OFFICE ENGINEERING & SERVICES	159,357,841	10.3%	70,287,240	5.4%	58,185,631	4.9%	-63.5%	-17.2%
FIELD OFFICE AND SERVICES	45,271,767	2.9%	39,724,134	3.1%	38,559,698	3.2%	-14.8%	-2.9%
TOTAL NI INDIRECT COST	312,576,487	20.2%	195,756,481	15.1%	180,302,707	15.1%	-42.3%	-7.9%
TOTAL NI BASE CONSTRUCTION COST	1,194,272,450	77.0%	996,039,021	76.8%	924,733,679	77.7%	-22.6%	-7.2%
ENERGY CONVERSION AREA (ECA)								
FACTORY EQUIPMENT	45,175,549	2.9%	45,175,549	3.5%	45,175,549	3.8%	0.0%	0.0%
SITE LABOR COST	24,393,247	1.6%	23,179,755	1.8%	22,448,913	1.9%	-8.0%	-3.2%
SITE MATERIAL	12,315,786	0.8%	12,315,786	0.9%	12,315,786	1.0%	0.0%	0.0%
TOTAL ECA DIRECT COST	81,884,582	5.3%	80,671,090	6.2%	79,940,248	6.7%	-2.4%	-0.9%
CONSTRUCTION SERVICES	15,123,813	1.0%	14,371,448	1.1%	13,918,326	1.2%	-8.0%	-3.2%
HOME OFFICE ENGINEERING & SERVICES	29,610,965	1.9%	4,030,438	0.3%	3,974,432	0.3%	-86.6%	-1.4%
FIELD OFFICE AND SERVICES	8,049,772	0.5%	7,649,319	0.6%	7,408,141	0.6%	-8.0%	-3.2%
TOTAL ECA INDIRECT COST	52,784,550	3.4%	26,051,205	2.0%	25,300,899	2.1%	-52.1%	-2.9%
TOTAL ECA BASE CONSTRUCTION COST	134,669,132	8.7%	106,722,295	8.2%	105,241,147	8.8%	-21.9%	-1.4%
TOTAL PLANT								
FACTORY EQUIPMENT	743,227,497	47.9%	669,166,341	51.6%	616,767,273	51.8%	-17.0%	-7.8%
SITE LABOR COST	141,298,448	9.1%	132,732,688	10.2%	128,549,346	10.8%	-9.0%	-3.2%
SITE MATERIAL	79,054,601	5.1%	79,054,601	6.1%	79,054,601	6.6%	0.0%	0.0%
TOTAL PLANT DIRECT COST	963,580,546	62.1%	880,953,630	67.9%	824,371,220	69.2%	-14.4%	-6.4%
CONSTRUCTION SERVICES	123,070,691	7.9%	100,116,555	7.7%	97,475,704	8.2%	-20.8%	-2.6%
HOME OFFICE ENGINEERING & SERVICES	188,968,806	12.2%	74,317,677	5.7%	62,160,063	5.2%	-67.1%	-16.4%
FIELD OFFICE AND SERVICES	53,321,539	3.4%	47,373,453	3.7%	45,967,839	3.9%	-13.8%	-3.0%
OWNER'S COSTS	221,715,397	3.4%	194,475,229	3.7%	160,571,427	3.9%	-27.6%	-17.4%
TOTAL PLANT INDIRECT COST	587,076,433	37.9%	416,282,915	32.1%	366,175,033	30.8%	-37.6%	-12.0%
TOTAL PLANT CONSTRUCTION COST	1,550,656,979	100.0%	1,297,236,545	100.0%	1,190,546,253	100.0%	-23.2%	-8.2%

TABLE 5–4(a)
MHTGR–GT/DC LEAD MODULE CREW MANHOURS

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	ENGINEER CREW	STRUCTURAL CREW	CONCRETE CREW	PIPING CREW	MECHANICAL CREW	ELECTRICAL CREW	INSTRUMENT CREW	TOTAL MANHOURS
	NUCLEAR ISLAND								
21	STRUCTURES & IMPROVEMENTS	166,926	171,552	768,511	21,982	5,755	107,643	0	1,242,369
22	REACTOR PLANT EQUIPMENT	34	31,731	318	105,096	143,508	29,004	34,374	344,065
23	TURBINE PLANT EQUIPMENT	0	0	0	0	0	0	5,480	5,480
24	ELECTRIC PLANT EQUIPMENT	0	0	0	0	0	614,614	0	614,614
25	MISCELLANEOUS PLANT EQUIPMENT	0	1,968	0	246,876	29,808	0	13,262	291,914
26	HEAT REJECTION SYSTEM								0
2	SUBTOTAL NUCLEAR ISLAND	166,960	205,251	768,829	373,954	179,071	751,261	53,116	2,498,442
	ENERGY CONVERSION AREA								
21	STRUCTURES & IMPROVEMENTS	21,185	99,974	28,618	2,500	39	11,539	0	163,855
22	REACTOR PLANT EQUIPMENT	0	0	0	17,705	2,325	0	3,735	23,765
23	TURBINE PLANT EQUIPMENT	0	0	0	2,928	500	0	5,055	8,483
24	ELECTRIC PLANT EQUIPMENT	878	550	0	980	517	62,009	0	64,934
25	MISCELLANEOUS PLANT EQUIPMENT	25,797	0	44,615	37,579	57,309	34,521	8,658	208,479
26	HEAT REJECTION SYSTEM	4,595	19,288	20,536	50,800	25,860	2,500	0	123,379
2	SUBTOTAL ENERGY CONVERSION AREA	52,455	119,812	93,769	112,492	86,350	110,569	17,448	592,895
	TOTAL MANHOURS	219,415	325,063	862,598	486,446	265,421	861,830	70,564	3,091,337

TABLE 5–4(b)
MHTGR–GT/DC PROTOTYPE PLANT CREW MANHOURS

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	ENGINEER CREW	STRUCTURAL CREW	CONCRETE CREW	PIPING CREW	MECHANICAL CREW	ELECTRICAL CREW	INSTRUMENT CREW	TOTAL MANHOURS
	NUCLEAR ISLAND								
21	STRUCTURES & IMPROVEMENTS	283,501	290,342	1,807,761	51,703	17,687	233,402	0	2,684,396
22	REACTOR PLANT EQUIPMENT	34	106,001	318	218,211	369,481	91,045	88,741	873,831
23	TURBINE PLANT EQUIPMENT	0	0	0	0	0	0	5,480	5,480
24	ELECTRIC PLANT EQUIPMENT	0	0	0	0	0	858,522	0	858,522
25	MISCELLANEOUS PLANT EQUIPMENT	0	1,968	0	246,876	61,165	0	15,482	325,491
26	HEAT REJECTION SYSTEM								0
2	SUBTOTAL NUCLEAR ISLAND	283,535	398,311	1,808,079	516,790	448,333	1,182,969	109,703	4,747,720
	ENERGY CONVERSION AREA								
21	STRUCTURES & IMPROVEMENTS	21,185	99,974	28,618	2,500	39	11,539	0	163,855
22	REACTOR PLANT EQUIPMENT	0	0	0	17,705	2,325	0	3,735	23,765
23	TURBINE PLANT EQUIPMENT	0	0	0	2,928	500	0	5,055	8,483
24	ELECTRIC PLANT EQUIPMENT	878	550	0	980	517	174,730	0	177,655
25	MISCELLANEOUS PLANT EQUIPMENT	25,797	0	44,615	53,008	58,758	34,521	8,658	225,357
26	HEAT REJECTION SYSTEM	14,538	66,581	62,043	176,652	32,744	8,693	0	361,251
2	SUBTOTAL ENERGY CONVERSION AREA	62,398	167,105	135,276	253,773	94,883	229,483	17,448	960,366
	TOTAL MANHOURS	345,933	565,416	1,943,355	770,563	543,216	1,412,452	127,151	5,708,086

TABLE 5–4(c)
MHTGR–GT/DC REPLICA PLANT CREW MANHOURS

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	ENGINEER CREW	STRUCTURAL CREW	CONCRETE CREW	PIPING CREW	MECHANICAL CREW	ELECTRICAL CREW	INSTRUMENT CREW	TOTAL MANHOURS
	NUCLEAR ISLAND								
21	STRUCTURES & IMPROVEMENTS	268,723	274,856	1,690,391	48,400	16,425	218,919	0	2,517,714
22	REACTOR PLANT EQUIPMENT	34	98,209	313	204,332	344,824	84,443	82,793	814,948
23	TURBINE PLANT EQUIPMENT	0	0	0	0	0	0	5,370	5,370
24	ELECTRIC PLANT EQUIPMENT	0	0	0	0	0	822,714	0	822,714
25	MISCELLANEOUS PLANT EQUIPMENT	0	1,928	0	241,938	57,546	0	15,003	316,415
26	HEAT REJECTION SYSTEM								0
2	SUBTOTAL NUCLEAR ISLAND	268,757	374,993	1,690,704	494,670	418,795	1,126,076	103,166	4,477,161
	ENERGY CONVERSION AREA								
21	STRUCTURES & IMPROVEMENTS	20,762	97,975	28,048	2,450	39	11,309	0	160,583
22	REACTOR PLANT EQUIPMENT	0	0	0	17,350	2,279	0	3,660	23,289
23	TURBINE PLANT EQUIPMENT	0	0	0	2,869	490	0	4,954	8,313
24	ELECTRIC PLANT EQUIPMENT	860	539	0	960	507	162,620	0	165,486
25	MISCELLANEOUS PLANT EQUIPMENT	25,283	0	43,722	50,770	57,472	33,831	8,485	219,563
26	HEAT REJECTION SYSTEM	13,455	61,625	57,424	163,500	31,550	8,046	0	335,600
2	SUBTOTAL ENERGY CONVERSION AREA	60,360	160,139	129,194	237,899	92,337	215,806	17,099	912,834
	TOTAL MANHOURS	329,117	535,132	1,819,898	732,569	511,132	1,341,882	120,265	5,389,995

TABLE 5–4(d)
MHTGR–GT/DC TARGET PLANT CREW MANHOURS

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	ENGINEER CREW	STRUCTURAL CREW	CONCRETE CREW	PIPING CREW	MECHANICAL CREW	ELECTRICAL CREW	INSTRUMENT CREW	TOTAL MANHOURS
	NUCLEAR ISLAND								
21	STRUCTURES & IMPROVEMENTS	260,250	266,195	1,637,112	46,873	15,907	212,021	0	2,438,358
22	REACTOR PLANT EQUIPMENT	32	95,115	302	197,894	333,965	81,780	80,185	789,273
23	TURBINE PLANT EQUIPMENT	0	0	0	0	0	0	5,202	5,202
24	ELECTRIC PLANT EQUIPMENT	0	0	0	0	0	796,789	0	796,789
25	MISCELLANEOUS PLANT EQUIPMENT	0	1,870	0	234,313	55,735	0	14,529	306,447
26	HEAT REJECTION SYSTEM								0
2	SUBTOTAL NUCLEAR ISLAND	260,282	363,180	1,637,414	479,080	405,607	1,090,590	99,916	4,336,069
	ENERGY CONVERSION AREA								
21	STRUCTURES & IMPROVEMENTS	20,105	94,886	27,161	2,373	37	10,952	0	155,514
22	REACTOR PLANT EQUIPMENT	0	0	0	16,803	2,206	0	3,545	22,554
23	TURBINE PLANT EQUIPMENT	0	0	0	2,779	475	0	4,798	8,052
24	ELECTRIC PLANT EQUIPMENT	833	522	0	930	491	157,493	0	160,269
25	MISCELLANEOUS PLANT EQUIPMENT	24,483	0	42,344	49,169	55,659	32,764	8,217	212,636
26	HEAT REJECTION SYSTEM	13,033	59,683	55,616	158,349	30,554	7,793	0	325,028
2	SUBTOTAL ENERGY CONVERSION AREA	58,454	155,091	125,121	230,403	89,422	209,002	16,560	884,053
	TOTAL MANHOURS	318,736	518,271	1,762,535	709,483	495,029	1,299,592	116,476	5,220,122

TABLE 5-5(a)
MHTGR-GT/DC LEAD MODULE CRAFT MANHOURS

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	BOILERMAKER	CARPENTER	ELECTRICIAN	IRONWORKER	LABORER	MILLWRIGHT	OPERATING ENGINEER	PIPE FITTER	TEAMSTER	OTHER	TOTALS
	NUCLEAR ISLAND											
21	STRUCTURES & IMPROVEMENTS	3,297	315,982	75,350	284,564	339,287	5,496	128,236	42,438	9,294	38,426	1,242,369
22	REACTOR PLANT EQUIPMENT	15,764	2,401	53,302	34,371	2,046	26,274	39,849	159,711	10,330	16	344,065
23	TURBINE PLANT EQUIPMENT	0	110	5,261	0	55	0	55	0	0	0	5,480
24	ELECTRIC PLANT EQUIPMENT	0	0	430,230	0	0	0	12,292	172,092	0	0	614,614
25	MISCELLANEOUS PLANT EQUIPMENT	37,031	364	12,732	26,164	231	61,719	34,524	110,253	8,897	0	291,914
26	HEAT REJECTION SYSTEM	0	0	0	0	0	0	0	0	0	0	0
2	SUBTOTAL NUCLEAR ISLAND	56,093	318,856	576,874	345,099	341,618	93,489	214,957	484,494	28,520	38,441	2,498,442
	ENERGY CONVERSION AREA											
21	STRUCTURES & IMPROVEMENTS	375	16,446	8,077	80,954	26,295	625	24,378	4,137	1,136	1,431	163,855
22	REACTOR PLANT EQUIPMENT	2,656	75	3,586	1,771	37	4,426	2,511	8,057	647	0	23,765
23	TURBINE PLANT EQUIPMENT	439	101	4,853	293	51	732	477	1,425	113	0	8,483
24	ELECTRIC PLANT EQUIPMENT	147	28	43,406	511	554	245	1,825	18,119	99	0	64,934
25	MISCELLANEOUS PLANT EQUIPMENT	5,637	18,019	32,476	12,681	28,949	9,395	25,143	68,666	5,283	2,231	208,479
26	HEAT REJECTION SYSTEM	7,620	9,179	1,750	23,653	9,882	12,700	15,523	39,008	3,037	1,027	123,379
2	SUBTOTAL ENERGY CONVERSION AREA	16,874	43,847	94,148	119,862	65,769	28,123	69,857	139,412	10,315	4,688	592,895
	TOTAL MANHOURS	72,967	362,704	671,022	464,961	407,387	121,612	284,814	623,905	38,835	43,130	3,091,337

TABLE 5-5(b)
MHTGR-GT/DC PROTOTYPE PLANT CRAFT MANHOURS

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	BOILERMAKER	CARPENTER	ELECTRICIAN	IRONWORKER	LABORER	MILLWRIGHT	OPERATING ENGINEER	PIPE FITTER	TEAMSTER	OTHER	TOTALS
	NUCLEAR ISLAND											
21	STRUCTURES & IMPROVEMENTS	7,755	737,622	163,381	564,479	726,946	12,926	246,690	97,598	16,610	90,388	2,664,396
22	REACTOR PLANT EQUIPMENT	32,732	7,202	148,923	101,385	6,303	54,553	100,244	397,451	25,022	16	873,831
23	TURBINE PLANT EQUIPMENT	0	110	5,261	0	55	0	55	0	0	0	5,480
24	ELECTRIC PLANT EQUIPMENT	0	0	600,965	0	0	0	17,170	240,386	0	0	858,522
25	MISCELLANEOUS PLANT EQUIPMENT	37,031	406	14,863	26,164	253	61,719	39,250	135,339	10,465	0	325,491
26	HEAT REJECTION SYSTEM	0	0	0	0	0	0	0	0	0	0	0
2	SUBTOTAL NUCLEAR ISLAND	77,519	745,341	933,393	712,028	733,557	129,198	403,409	870,774	52,097	90,404	4,747,720
	ENERGY CONVERSION AREA											
21	STRUCTURES & IMPROVEMENTS	375	16,446	8,077	80,954	26,295	625	24,378	4,137	1,136	1,431	163,855
22	REACTOR PLANT EQUIPMENT	2,656	75	3,586	1,771	37	4,426	2,511	8,057	647	0	23,765
23	TURBINE PLANT EQUIPMENT	439	101	4,853	293	51	732	477	1,425	113	0	8,483
24	ELECTRIC PLANT EQUIPMENT	147	28	122,311	511	554	245	4,080	49,661	99	0	177,655
25	MISCELLANEOUS PLANT EQUIPMENT	7,951	18,019	32,476	14,224	28,949	13,252	27,211	75,225	5,818	2,231	225,357
26	HEAT REJECTION SYSTEM	26,496	28,146	6,085	80,010	30,665	44,163	44,461	90,457	7,664	3,102	361,251
2	SUBTOTAL ENERGY CONVERSION AREA	38,066	62,815	177,388	177,761	86,551	63,443	103,118	228,982	15,477	6,764	960,366
	TOTAL MANHOURS	115,584	808,156	1,110,781	889,789	820,109	192,641	506,527	1,099,756	67,574	97,168	5,708,086

TABLE 5-5(c)
MHTGR-GT/DC REPLICA PLANT CRAFT MANHOURS

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	BOILERMAKER	CARPENTER	ELECTRICIAN	IRONWORKER	LABORER	MILLWRIGHT	OPERATING ENGINEER	PIPE FITTER	TEAMSTER	OTHER	TOTALS
	NUCLEAR ISLAND											
21	STRUCTURES & IMPROVEMENTS	7,260	689,899	153,243	549,060	682,094	12,100	232,451	91,377	15,709	84,520	2,517,714
22	REACTOR PLANT EQUIPMENT	30,650	6,692	138,591	94,153	5,853	51,083	93,519	371,019	23,373	16	814,948
23	TURBINE PLANT EQUIPMENT	0	107	5,155	0	54	0	54	0	0	0	5,370
24	ELECTRIC PLANT EQUIPMENT	0	0	575,900	0	0	0	16,454	230,360	0	0	822,714
25	MISCELLANEOUS PLANT EQUIPMENT	36,291	396	14,403	25,640	246	60,485	38,104	130,715	10,135	0	316,415
26	HEAT REJECTION SYSTEM	0	0	0	0	0	0	0	0	0	0	0
2	SUBTOTAL NUCLEAR ISLAND	74,201	697,095	887,293	668,853	688,247	123,668	380,582	823,472	49,218	84,536	4,477,161
	ENERGY CONVERSION AREA											
21	STRUCTURES & IMPROVEMENTS	368	16,118	7,916	79,336	25,770	613	23,891	4,055	1,114	1,402	160,583
22	REACTOR PLANT EQUIPMENT	2,603	73	3,514	1,735	37	4,338	2,460	7,896	634	0	23,289
23	TURBINE PLANT EQUIPMENT	430	99	4,756	287	50	717	467	1,396	111	0	8,313
24	ELECTRIC PLANT EQUIPMENT	144	27	113,834	500	543	240	3,826	46,275	97	0	165,486
25	MISCELLANEOUS PLANT EQUIPMENT	7,616	17,659	31,827	13,821	28,371	12,693	26,510	73,220	5,661	2,186	219,563
26	HEAT REJECTION SYSTEM	24,525	26,051	5,632	74,054	28,381	40,875	41,338	84,718	7,155	2,871	335,600
2	SUBTOTAL ENERGY CONVERSION AREA	35,685	60,027	167,479	169,733	83,152	59,475	98,492	217,560	14,772	6,460	912,834
	TOTAL MANHOURS	109,885	757,121	1,054,772	838,586	771,399	183,142	479,074	1,041,032	63,990	90,995	5,389,995

TABLE 5-5(d)
MHTGR-GT/DC TARGET PLANT CRAFT MANHOURS

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	BOILERMAKER	CARPENTER	ELECTRICIAN	IRONWORKER	LABORER	MILLWRIGHT	OPERATING ENGINEER	PIPE FITTER	TEAMSTER	OTHER	TOTALS
	NUCLEAR ISLAND											
21	STRUCTURES & IMPROVEMENTS	7,031	668,155	148,415	531,756	660,593	11,718	225,124	88,497	15,214	81,856	2,438,358
22	REACTOR PLANT EQUIPMENT	29,684	6,480	134,224	91,186	5,667	49,474	90,573	359,333	22,637	15	789,273
23	TURBINE PLANT EQUIPMENT	0	104	4,994	0	52	0	52	0	0	0	5,202
24	ELECTRIC PLANT EQUIPMENT	0	0	557,752	0	0	0	15,936	223,101	0	0	796,789
25	MISCELLANEOUS PLANT EQUIPMENT	35,147	384	13,948	24,834	239	58,578	36,904	126,598	9,816	0	306,447
26	HEAT REJECTION SYSTEM	0	0	0	0	0	0	0	0	0	0	0
2	SUBTOTAL NUCLEAR ISLAND	71,862	675,123	859,332	647,776	666,552	119,770	368,588	797,529	47,667	81,871	4,336,069
	ENERGY CONVERSION AREA											
21	STRUCTURES & IMPROVEMENTS	356	15,609	7,666	76,834	24,956	593	23,137	3,927	1,078	1,358	155,514
22	REACTOR PLANT EQUIPMENT	2,520	71	3,403	1,680	35	4,201	2,383	7,646	614	0	22,554
23	TURBINE PLANT EQUIPMENT	417	96	4,606	278	48	695	453	1,353	107	0	8,052
24	ELECTRIC PLANT EQUIPMENT	140	26	110,245	485	526	233	3,705	44,816	94	0	160,269
25	MISCELLANEOUS PLANT EQUIPMENT	7,375	17,102	30,823	13,386	27,475	12,292	25,673	70,910	5,482	2,117	212,636
26	HEAT REJECTION SYSTEM	23,752	25,231	5,455	71,720	27,489	39,587	40,036	82,047	6,930	2,781	325,028
2	SUBTOTAL ENERGY CONVERSION AREA	34,560	58,134	162,199	164,383	80,529	57,601	95,386	210,699	14,306	6,256	884,053
	TOTAL MANHOURS	106,422	733,257	1,021,531	812,159	747,080	177,371	463,974	1,008,228	61,973	88,127	5,220,122

TABLE 5–6(a)
MHTGR–GT/DC LEAD MODULE CRAFT MANHOURS

CRAFT	ACCOUNT 21	ACCOUNT 22	ACCOUNT 23	ACCOUNT 24	ACCOUNT 25	ACCOUNT 26	TOTAL MANHOURS	% OF TOTAL
BOILERMAKER	3,672	18,420	439	147	42,668	7,620	72,967	2.4%
CARPENTER	332,428	2,476	211	28	18,383	9,179	362,704	11.7%
ELECTRICIAN	83,427	56,887	10,114	473,636	45,208	1,750	671,022	21.7%
IRONWORKER	365,519	36,142	293	511	38,845	23,653	464,961	15.0%
LABORER	365,582	2,083	105	554	29,180	9,882	407,387	13.2%
MILLWRIGHT	6,121	30,700	732	245	71,114	12,700	121,612	3.9%
OPERATING ENGINEER	152,615	42,360	532	14,117	59,667	15,523	284,814	9.2%
PIPEFITTER	46,575	167,768	1,425	190,211	178,919	39,006	623,905	20.2%
TEAMSTER	10,430	10,977	113	99	14,179	3,037	38,835	1.3%
OTHER	39,856	16	0	0	2,231	1,027	43,130	1.4%
TOTAL CRAFT MANHOURS	1,406,224	367,830	13,963	679,548	500,393	123,379	3,091,337	100.0%
% OF TOTAL	45.5%	11.9%	0.5%	22.0%	16.2%	4.0%	100.0%	N/A

TABLE 5–6(b)
MHTGR–GT/DC PROTOTYPE PLANT CRAFT MANHOURS

CRAFT	ACCOUNT 21	ACCOUNT 22	ACCOUNT 23	ACCOUNT 24	ACCOUNT 25	ACCOUNT 26	TOTAL MANHOURS	% OF TOTAL
BOILERMAKER	8,130	35,387	439	147	44,983	26,498	115,584	2.0%
CARPENTER	754,067	7,277	211	28	18,427	28,146	808,156	14.2%
ELECTRICIAN	171,459	152,508	10,114	723,276	47,339	6,085	1,110,781	19.5%
IRONWORKER	665,433	103,156	293	511	40,387	80,010	889,789	15.6%
LABORER	753,241	6,341	105	554	29,203	30,665	820,109	14.4%
MILLWRIGHT	13,551	58,979	732	245	74,971	44,163	192,641	3.4%
OPERATING ENGINEER	271,069	102,754	532	21,250	66,461	44,461	506,527	8.9%
PIPEFITTER	101,735	405,508	1,425	290,067	210,564	90,457	1,099,756	19.3%
TEAMSTER	17,747	25,669	113	99	16,283	7,664	67,574	1.2%
OTHER	91,819	16	0	0	2,231	3,102	97,168	1.7%
TOTAL CRAFT MANHOURS	2,848,251	897,596	13,963	1,036,177	550,848	361,251	5,708,086	100.0%
% OF TOTAL	49.9%	15.7%	0.2%	18.2%	9.7%	6.3%	100.0%	N/A

TABLE 5–6(c)
MHTGR–GT/DC REPLICA PLANT CRAFT MANHOURS

CRAFT	ACCOUNT 21	ACCOUNT 22	ACCOUNT 23	ACCOUNT 24	ACCOUNT 25	ACCOUNT 26	TOTAL MANHOURS	% OF TOTAL
BOILERMAKER	7,628	33,252	430	144	43,906	24,525	109,885	2.0%
CARPENTER	706,017	6,765	206	27	18,055	26,051	757,121	14.0%
ELECTRICIAN	161,160	142,105	9,911	689,734	46,230	5,632	1,054,772	19.6%
IRONWORKER	628,396	95,888	287	500	39,461	74,054	838,586	15.6%
LABORER	707,864	5,889	103	543	28,618	26,381	771,399	14.3%
MILLWRIGHT	12,713	55,421	717	240	73,177	40,875	183,142	3.4%
OPERATING ENGINEER	256,343	95,980	521	20,280	64,614	41,338	479,074	8.9%
PIPEFITTER	95,433	378,915	1,396	276,635	203,935	84,718	1,041,032	19.3%
TEAMSTER	16,823	24,007	111	97	15,796	7,155	63,990	1.2%
OTHER	85,922	16	0	0	2,186	2,871	90,995	1.7%
TOTAL CRAFT MANHOURS	2,678,297	838,237	13,683	988,200	535,978	335,600	5,389,995	100.0%
% OF TOTAL	49.7%	15.6%	0.3%	18.3%	9.9%	6.2%	100.0%	N/A

TABLE 5–6(d)
MHTGR–GT/DC TARGET PLANT CRAFT MANHOURS

CRAFT	ACCOUNT 21	ACCOUNT 22	ACCOUNT 23	ACCOUNT 24	ACCOUNT 25	ACCOUNT 26	TOTAL MANHOURS	% OF TOTAL
BOILERMAKER	7,387	32,205	417	140	42,522	23,752	106,422	2.0%
CARPENTER	683,763	6,551	200	26	17,486	25,231	733,257	14.0%
ELECTRICIAN	156,081	137,627	9,600	667,997	44,771	5,455	1,021,531	19.6%
IRONWORKER	608,590	92,866	278	485	38,220	71,720	812,159	15.6%
LABORER	685,549	5,703	100	526	27,714	27,489	747,080	14.3%
MILLWRIGHT	12,312	53,674	695	233	70,871	39,587	177,371	3.4%
OPERATING ENGINEER	248,261	92,956	505	19,641	62,576	40,036	463,974	8.9%
PIPEFITTER	92,424	366,979	1,353	267,917	197,508	82,047	1,008,228	19.3%
TEAMSTER	16,292	23,251	107	94	15,298	6,930	61,973	1.2%
OTHER	83,214	15	0	0	2,117	2,781	88,127	1.7%
TOTAL CRAFT MANHOURS	2,593,872	811,827	13,254	957,058	519,083	325,028	5,220,122	100.0%
% OF TOTAL	49.7%	15.6%	0.3%	18.3%	9.9%	6.2%	100.0%	N/A

TABLE 5-7
MHTGR-GT/DC REACTOR PLANT EQUIPMENT COSTS

ACCOUNT NUMBER	REACTOR PLANT EQUIPMENT	LEARNING FACTOR	EQUIPMENT FOAK COSTS	LEAD MODULE	LEAD MODULE W/FOAK	PROTOTYPE PLANT	PROTOTYPE W/FOAK	REPLICA PLANT	TARGET PLANT
221	REACTOR SYSTEM								
221.3111 .	NEUTRON CONTROL	94%	1,400,000	3,799,000	5,199,000	14,170,974	15,570,974	12,876,677	11,510,013
221.31121.	GRAPHITE REACTOR INTERNALS	94%	4,263,000	8,713,000	12,976,000	32,501,104	36,764,104	29,532,637	26,398,194
221.31122	METALLIC REACTOR INTERNALS	94%	300,000	17,400,000	17,700,000	64,905,224	65,205,224	58,977,148	52,717,615
221.3113 .	REACTOR CORE (W/O FUEL)	94%	1,850,000	3,830,000	5,680,000	14,286,610	16,136,610	12,981,752	11,603,935
221.1114 .	REACTOR SERVICE EQUIPMENT	94%	701,000	9,792,000	10,493,000	9,792,000	10,493,000	9,204,480	8,344,646
222	VESSEL SYSTEM								
222.31211.	REACTOR VESSEL & CROSS VESSEL	98%	2,350,000	20,450,000	22,800,000	79,936,733	82,286,733	77,492,109	74,706,474
222.31212.	POWER CONVERSION VESSEL	98%	2,000,000	12,390,000	14,390,000	48,431,106	50,431,106	46,949,987	45,262,260
222.3122 .	PRESSURE RELIEF	94%	320,000	1,010,000	1,330,000	3,767,487	4,087,487	3,423,386	3,060,045
222.3123 .	VESSEL SUPPORTS	94%	0	4,520,000	4,520,000	16,860,437	16,860,437	15,320,501	13,694,461
223	HEAT TRANSPORT SYSTEM								
223.31310.	RECUPERATOR	94%	1,500,000	11,250,000	12,750,000	41,964,584	43,464,584	38,131,777	34,084,665
223.31320.	PRECOOLER/INTERCOOLER	96%	670,000	8,540,000	9,210,000	32,613,811	33,283,811	30,623,402	28,439,133
223.31330.	HEAT TRANSPORT SYSTEM INTERNALS	94%	2,800,000	10,320,000	13,120,000	38,495,512	41,295,512	34,979,550	31,266,999
223.11340.	HTS SERVICE SYSTEM EQUIPMENT	94%	0	0	0	0	0	0	0
224	SHUTDOWN COOLING SYSTEM								
224.31410.	SHUTDOWN CIRCULATOR	94%	194,000	1,166,000	1,360,000	4,349,396	4,543,396	3,952,147	3,532,686
224.31420.	SHUTDOWN COOLING HEAT EXCHANGER	96%	920,000	2,280,000	3,200,000	8,707,200	9,627,200	8,175,803	7,592,649
224.31430.	SHUTDOWN COOLING SYSTEM CONTROLS	94%	168,000	416,000	584,000	1,551,757	1,719,757	1,410,028	1,260,375
224.11440.	SCS SERVICE EQUIPMENT	94%	175,000	392,000	567,000	392,000	567,000	368,480	334,059
227	REACTOR SERVICE SYSTEM								
227.12110.0	CORE REFUELING	94%	1,974,000	13,734,000	15,708,000	13,734,000	15,708,000	12,909,960	11,703,979
227.52110.2	CORE REFUELING	94%	0	7,336,000	7,336,000	14,231,840	14,231,840	13,132,799	11,796,956
227.12120.	SITE FUEL HANDLING	94%	158,000	2,860,000	3,018,000	2,860,000	3,018,000	2,688,400	2,437,264
227.32410.0	HELIUM PURIFICATION	94%	125,000	644,000	769,000	2,402,239	2,527,239	2,182,832	1,951,158
227.52410.2	HELIUM PURIFICATION	94%	0	229,000	229,000	444,260	444,260	409,952	368,315
228	PLANT CONTROL, PROTECTION, & MONITORING								
228.33100.0	REACTOR PROTECTION SYSTEM	94%	53,000	364,000	417,000	1,357,787	1,410,787	1,233,775	1,102,828
228.33300.0	INVESTMENT PROTECTION & INSTR	94%	105,000	469,000	574,000	1,749,457	1,854,457	1,589,671	1,420,952
228.13400.0	PLANT SIMULATOR	94%	730,000	4,160,000	4,890,000	4,160,000	4,890,000	3,910,400	3,545,111
228.53400.2	PLANT CONTROL SYSTEM	94%	108,000	1,639,000	1,747,000	3,179,660	3,287,660	2,934,114	2,636,108
228.33540.0	NI ANALYTICAL INSTRUMENTATION	94%	54,000	137,000	191,000	511,035	565,035	464,360	415,075
229	REACTOR PLANT MISCELLANEOUS ITEMS								
229.1001	REACTOR PLANT MISC. ITEMS	94%	0	5,000,000	5,000,000	5,000,000	5,000,000	4,700,000	4,260,951
229.10011.	CHECKOUT & STARTUP TEST EQUIPMENT	94%	1,311,000	2,479,000	3,790,000	2,479,000	3,790,000	2,330,260	2,112,579
229.10012.	MAINTENANCE MONITORING & ISI EQUIP	94%	261,000	1,491,000	1,752,000	1,491,000	1,752,000	1,401,540	1,270,616
229.30030.	TRANSPORTATION OF MAJOR EQUIPMENT	100%	610,000	530,000	1,140,000	2,120,000	2,730,000	2,120,000	2,120,000
23	TURBINE PLANT EQUIPMENT								
231.3	TURBOMACHINERY	94%	500,000	38,950,000	39,450,000	145,290,716	145,790,716	132,020,685	118,008,683
237.1	OVERALL PLANT CONTROL SYSTEM	94%	30,000	170,000	200,000	170,000	200,000	159,800	144,872
237.3	PLANT CONTROL & SAFETY VALVE SYSTEM	94%	0	662,000	662,000	2,469,383	2,469,383	2,243,843	2,005,693
	TOTAL DIRECT COST		25,630,000	197,122,000	222,752,000	616,376,313	642,006,313	570,832,256	521,111,350

TABLE 5-8
MHTGR-GT/DC LEAD MODULE BULK COMMODITIES

ACCOUNT NUMBER	FORMWORK (SF)	STRUCTURAL STEEL (TN)	REINFORCING STEEL (TN)	EMBEDDED STEEL (TN)	STRUCTURAL CONCRETE (CY)	CONCRETE FILL (CY)	CS PIPE <2.5" (LF)	CS PIPE >2" (LF)	SS PIPE <2.5" (LF)	SS PIPE >2" (LF)	CM PIPE >2" (LF)	POWER CABLE (LF)	CONTROL CABLE (LF)	CABLE TRAY (LF)
NI														
21	515,390	2,169	8,976	187	53,037		30	400						
22	260		5	0	35		8,800	7,150	450	500			90,000	
23														
24												474,000	125,000	10,500
25														
26														
SUBTOTAL NI	515,650	2,169	8,981	187	53,072	0	8,830	7,550	450	500	0	474,000	215,000	10,500
ECA														
21	17,647	17	286	0	3,976									
22							750	0	1,250	150				
23				0			115	0	0	400				
24												91,000	50,000	4,000
25	780		26	0	390		1,050	1,900	1,200	0				
26	10,350	4	337	0	4,568			2,000						
SUBTOTAL ECA	28,777	21	649	0	8,934	0	1,915	3,900	2,450	550	0	91,000	50,000	4,000
TOTAL PLANT														
21	533,037	2,186	9,262	187	57,013	0	30	400	0	0	0	0	0	0
22	260	0	5	0	35	0	9,550	7,150	1,700	650	0	0	90,000	0
23	0	0	0	0	0	0	115	0	0	400	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	565,000	175,000	14,500
25	780	0	26	0	390	0	1,050	1,900	1,200	0	0	0	0	0
26	10,350	4	337	0	4,568.	0	0	2,000	0	0	0	0	0	0
TOTAL PLANT	544,427	2,190	9,630	187	62,006	0	10,745	11,450	2,900	1,050	0	565,000	265,000	14,500
UNITS	SF/MWe	TN/MWe	TN/MWe	TN/MWe	CY/MWe	CY/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe
NI	2,374	10	41	1	244	0	41	35	2	2	0	2,182	990	48
ECA	132	0	3	0	41	0	9	18	11	3	0	419	230	18
TOTAL PLANT	2,506	10	44	1	285	0	49	53	13	5	0	2,601	1,220	67

TABLE 5–9
MHTGR–GT/DC PLANT BULK COMMODITIES

ACCOUNT NUMBER	FORMWORK (SF)	STRUCTURAL STEEL (TN)	REINFORCING STEEL (TN)	EMBEDDED STEEL (TN)	STRUCTURAL CONCRETE (CY)	CONCRETE FILL (CY)	CS PIPE <2.5" (LF)	CS PIPE >2" (LF)	SS PIPE <2.5" (LF)	SS PIPE >2" (LF)	CM PIPE >2" (LF)	POWER CABLE (LF)	CONTROL CABLE (LF)	CABLE TRAY (LF)
NI														
21	1,329,320	3,770	24,945	515	123,737		120	1,600						
22	260		5	0	35		15,350	18,300	1,800	2,000			90,000	
23														
24												1,896,000	500,000	42,000
25														
26														
SUBTOTAL NI	1,329,580	3,770	24,950	515	123,772	0	15,470	19,900	1,800	2,000	0	1,896,000	590,000	42,000
ECA														
21	17,647	17	286	14	3,976									
22							750	0	1,250	150				
23							115	0	0	400				
24												364,000	200,000	16,000
25	780		26	3	390		1,050	7,300	1,200	0				
26	26,700	8	1,274	13	17,136			8,000						
SUBTOTAL ECA	45,127	25	1,586	30	21,502	0	1,915	15,300	2,450	550	0	364,000	200,000	16,000
TOTAL PLANT														
21	1,346,967	3,787	25,231	529	127,713	0	120	1,600	0	0	0	0	0	0
22	260	0	5	0	35	0	16,100	18,300	3,050	2,150	0	0	90,000	0
23	0	0	0	0	0	0	115	0	0	400	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	2,260,000	700,000	58,000
25	780	0	26	3	390	0	1,050	7,300	1,200	0	0	0	0	0
26	26,700	8	1,274	13	17,136	0	0	8,000	0	0	0	0	0	0
TOTAL PLANT	1,374,707	3,795	26,536	546	145,274	0	17,385	35,200	4,250	2,550	0	2,260,000	790,000	58,000
UNITS	SF/MWe	TN/MWe	TN/MWe	TN/MWe	CY/MWe	CY/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe	LF/MWe
NI	1,530	4	29	1	142	0	18	23	2	2	0	2,182	679	48
ECA	52	0	2	0	25	0	2	18	3	1	0	419	230	18
TOTAL PLANT	1,582	4	31	1	167	0	20	41	5	3	0	2,601	909	67

TABLE 5–10
MHTGR–GT/DC OWNER'S COST ESTIMATE

OWNER'S COST ACCOUNT	LEAD MODULE	PROTOTYPE PLANT	REPLICA PLANT	TARGET PLANT
941.1 ENGINEERING/SITE MANAGEMENT	2,532,600	4,536,972	1,729,404	1,461,672
941.2 QUALITY ASSURANCE	1,894,455	3,395,466	1,374,381	1,344,222
941.3 PROJECT LICENSING	4,555,899	6,335,118	2,764,341	2,098,386
941.4 PROJECT MANAGEMENT & CONTROL	4,817,325	7,689,350	3,838,535	3,172,360
941 PROJECT MANAGEMENT	13,800,279	21,956,906	9,706,661	8,076,640
942.1 PROPERTY TAXES	0	32,000,000	48,000,000	42,000,000
942.2 LICENSING FEES & PERMITS	9,975,000	16,450,000	5,600,000	5,600,000
942.3 INSURANCE	0	4,200,000	4,200,000	2,410,000
942 FEES, TAXES, & INSURANCE	9,975,000	52,650,000	57,800,000	50,010,000
943.1 INITIAL SPARE PARTS INVENTORY	43,600,000	48,700,000	45,700,000	41,500,000
943.2 CONSUMABLES, SUPPLIES, & COOLANTS	470,892	1,242,938	1,245,684	1,254,256
943.3 PLANT EQUIPMENT & FURNISHINGS	10,100,000	13,500,000	13,500,000	13,500,000
943 SPARE PARTS AND CAPITAL EQUIPMENT	54,170,892	63,442,938	60,445,684	56,254,256
944.1 SITE STAFF TRAINING & STARTUP	32,766,683	45,333,032	37,670,769	24,183,972
944.2 MAINTENANCE MATERIALS	595,833	1,404,167	1,012,500	764,167
944.3 SUPPLIES & EXPENSES	2,178,462	5,011,047	4,630,181	3,478,386
944 STAFF TRAINING AND STARTUP	35,540,977	51,748,245	43,313,450	28,426,524
945 GENERAL AND ADMINISTRATIVE	15,526,822	20,572,213	17,019,869	13,913,613
TOTAL OWNERS COSTS	129,013,971	210,370,302	188,285,664	156,681,033

TABLE 5–11
MHTGR–GT/DC TARGET PLANT COST BY ESTIMATOR

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	COST ESTIMATOR					TOTAL COST	% OF TOTAL
		BNI/NI	BNI/ECA	GA	ABB–CE	GCRA		
20	LAND & LAND RIGHTS	0	0	0	0	2,000,000	2,000,000	0.17%
211	YARDWORK	3,788,769	591,644	0	0	0	4,380,413	0.37%
212.1	REACTOR BUILDING	93,861,602	0	0	0	0	93,861,602	7.88%
212.2	REACTOR AUXILIARY BUILDING	0	0	0	0	0	0	0.00%
212.3	REACTOR SERVICE BUILDING	14,073,563	0	0	0	0	14,073,563	1.18%
212.4	PERSONNEL SERVICE BUILDING	2,183,467	0	0	0	0	2,183,467	0.18%
212.5	RADWASTE BUILDING	4,077,001	0	0	0	0	4,077,001	0.34%
212	REACTOR COMPLEX	114,195,633	0	0	0	0	114,195,633	9.59%
213	TURBINE COMPLEX	0	2,382,111	0	0	0	2,382,111	0.20%
214	OPERATIONS CENTER	0	4,339,885	0	0	0	4,339,885	0.36%
215	REMOTE SHUTDOWN BUILDING	145,137	0	0	0	0	145,137	0.01%
216	OTHER BUILDINGS	1,535,798	1,528,038	0	0	0	3,063,836	0.26%
21	STRUCTURES & IMPROVEMENTS	119,665,337	8,841,678	0	0	0	128,507,015	10.79%
221	REACTOR SYSTEM	1,678,533	0	57,856,767	52,717,615	0	112,252,935	9.43%
222	VESSEL SYSTEM	8,927,820	0	0	136,723,240	0	145,651,060	12.23%
223	HEAT TRANSPORT SYSTEM	1,731,595	0	34,064,665	59,706,132	0	95,522,392	8.02%
224	SHUTDOWN COOLING SYSTEM	692,156	0	5,127,120	7,592,649	0	13,411,925	1.13%
225	SHUTDOWN COOLING WATER SYSTEM	3,703,397	0	0	0	0	3,703,397	0.31%
226	REACTOR CAVITY COOLING SYSTEM	14,445,579	0	0	0	0	14,445,579	1.21%
227	REACTOR SERVICE SYSTEM	21,641,625	1,382,680	28,259,673	0	0	51,283,978	4.31%
228	REACTOR CONTROL, PROTECTION & MONITORING	4,227,955	281,332	9,120,075	0	0	13,629,362	1.14%
229	REACTOR PLANT MISCELLANEOUS	732,624	0	3,383,195	6,380,951	0	10,496,770	0.88%
22	REACTOR PLANT EQUIPMENT	57,781,284	1,664,012	137,831,514	263,120,587	0	460,397,397	38.67%
231	TURBINE GENERATOR & AUXILIARIES	0	0	0	118,008,683	0	118,008,683	9.91%
233	MAIN & AUXILIARY STEAM SYSTEM	0	256,451	0	0	0	256,451	0.02%
234	FEEDWATER & CONDENSATE SYSTEM	0	0	0	0	0	0	0.00%
235	STARTUP & SHUTDOWN SYSTEM	0	0	0	0	0	0	0.00%
236	TURBINE PLANT SAMPLING SYSTEM	0	0	0	0	0	0	0.00%
237	ECA CONTROL, DATA & INSTRUMENTATION	182,425	2,144,175	2,150,565	0	0	4,477,165	0.38%
23	TURBINE PLANT EQUIPMENT	182,425	2,400,626	2,150,565	118,008,683	0	122,742,300	10.31%
241	SWITCHGEAR	331,808	6,514,435	0	0	0	6,846,243	0.58%
242	STATION SERVICE EQUIPMENT	7,076,473	6,014,333	0	0	0	13,090,806	1.10%
243	SWITCHBOARDS	20,186	3,680,549	0	0	0	3,700,735	0.31%
244	PROTECTIVE EQUIPMENT	0	635,085	0	0	0	635,085	0.05%
245	ELECTRIC STRUCTURES & WIRING CONTAINERS	10,840,072	1,508,442	0	0	0	12,348,514	1.04%
246	POWER AND CONTROL WIRING	10,780,015	5,557,201	0	0	0	16,337,216	1.37%
24	ELECTRIC PLANT EQUIPMENT	29,048,554	23,910,045	0	0	0	52,958,599	4.45%
251	TRANSPORTATION AND LIFT EQUIPMENT	1,734,380	398,054	0	0	0	2,132,434	0.18%
252	AIR, WATER, AND STEAM SERVICE SYSTEM	11,192,721	11,412,598	0	0	0	22,605,319	1.90%
253	COMMUNICATIONS AND SECURITY EQUIPMENT	2,354,178	1,817,990	0	0	0	4,172,168	0.35%
254	FURNISHINGS AND FIXTURES	1,360,743	536,408	0	0	0	1,897,151	0.16%
25	MISCELLANEOUS PLANT EQUIPMENT	16,642,022	14,165,050	0	0	0	30,807,072	2.59%
261	CIRCULATING AND SERVICE WATER PUMPHOUSE	0	413,243	0	0	0	413,243	0.03%
262	ECA COOLING WATER SYSTEMS	0	10,102,942	0	0	0	10,102,942	0.85%
263	CIRCULATING AND SERVICE WATER SYSTEM	0	16,442,652	0	0	0	16,442,652	1.38%
26	HEAT REJECTION SYSTEM	0	26,958,837	0	0	0	26,958,837	2.26%
2	TOTAL DIRECT COSTS	223,319,622	77,940,248	139,982,080	381,129,270	2,000,000	824,371,220	69.24%
911	TEMPORARY CONSTRUCTION FACILITIES	39,271,968	6,541,613	0	0	0	45,813,581	3.85%
912	CONSTRUCTION TOOLS AND EQUIPMENT	20,053,771	3,340,398	0	0	0	23,394,169	1.96%
913	PAYROLL INSURANCE AND TAXES	23,396,066	3,897,131	0	0	0	27,293,197	2.29%
914	PERMITS, INSURANCE, AND LOCAL TAXES	835,574	139,183	0	0	0	974,757	0.08%
91	CONSTRUCTION SERVICES	83,557,378	13,918,326	0	0	0	97,475,704	8.19%
920	REACTOR MODULE ENGINEERING AND SERVICES	0	0	18,267,117	0	0	18,267,117	1.53%
921	PLANT ENGINEERING AND SERVICES	29,938,886	2,980,824	0	0	0	32,919,709	2.77%
922	HOME OFFICE QUALITY ASSURANCE	997,963	99,361	0	0	0	1,097,324	0.09%
923	HOME OFFICE PROJECT & CONSTRUCTION MGMT.	8,981,666	894,247	0	0	0	9,875,913	0.83%
92	ENGINEERING AND HOME OFFICE SERVICES	39,918,514	3,974,432	18,267,117	0	0	62,160,063	5.22%
931	FIELD OFFICE EXPENSES	5,398,358	1,037,140	0	0	0	6,435,497	0.54%
932	FIELD JOB SUPERVISION	21,207,834	4,074,478	0	0	0	25,282,312	2.12%
933	FIELD QUALITY ASSURANCE/QUALITY CONTROL	1,927,985	370,407	0	0	0	2,298,392	0.19%
934	PLANT STARTUP AND TEST	10,025,521	1,926,117	0	0	0	11,951,638	1.00%
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	38,559,698	7,408,141	0	0	0	45,967,839	3.86%
941	PROJECT MANAGEMENT EXPENSES	0	0	0	0	8,233,510	8,233,510	0.69%
942	FEES, TAXES, AND INSURANCE	0	0	0	0	50,010,000	50,010,000	4.20%
943	SPARE PARTS AND CAPITAL EQUIPMENT	0	0	0	0	59,654,256	59,654,256	5.01%
944	STAFF TRAINING AND STARTUP	0	0	0	0	28,252,605	28,252,605	2.37%
945	GENERAL & ADMINISTRATIVE	0	0	0	0	14,421,056	14,421,056	1.21%
94	OWNER'S COSTS	0	0	0	0	160,571,427	160,571,427	13.49%
9	TOTAL INDIRECT COSTS	162,035,590	25,300,899	18,267,117	0	160,571,427	366,175,033	30.76%
	TOTAL BASE CONSTRUCTION COST	385,355,212	103,241,147	158,249,197	381,129,270	162,571,427	1,190,546,253	100.00%
		32.37%	8.67%	13.29%	32.01%	13.66%	100.00%	

TABLE 5–12
MHTGR–GT/DC PLANT CONTINGENCIES BY ACCOUNT

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	LEAD MODULE		PROTOTYPE		REPLICA		TARGET	
		1992$	%	1992$	%	1992$	%	1992$	%
20	LAND & LAND RIGHTS	300,000	15.0%	300,000	15.0%	300,000	15.0%	300,000	15.0%
211	YARDWORK	915,128	20.2%	915,128	20.2%	900,947	20.1%	886,492	20.2%
212	REACTOR COMPLEX	10,065,126	19.9%	24,752,421	20.6%	23,928,121	20.6%	23,555,861	20.6%
213	TURBINE COMPLEX	366,933	15.0%	366,933	15.0%	357,316	14.8%	363,165	15.2%
214	OPERATIONS CENTER	665,364	15.0%	665,364	15.0%	650,983	14.8%	659,714	15.2%
215	REMOTE SHUTDOWN BUILDING	28,452	19.0%	28,452	19.0%	28,115	19.0%	27,577	19.0%
216	OTHER BUILDINGS	469,452	15.0%	469,452	15.0%	462,800	14.9%	462,362	15.1%
21	STRUCTURES & IMPROVEMENTS	12,510,455	19.1%	27,197,750	20.2%	26,328,282	20.2%	25,955,171	20.2%
221	REACTOR SYSTEM	14,919,373	28.4%	43,013,064	29.5%	37,208,061	29.7%	33,319,383	29.7%
222	VESSEL SYSTEM	13,125,455	28.7%	46,930,725	28.8%	43,764,443	28.7%	41,823,879	28.7%
223	HEAT TRANSPORT SYSTEM	9,770,664	27.4%	32,494,921	27.1%	28,382,391	26.9%	25,619,972	26.8%
224	SHUTDOWN COOLING SYSTEM	1,653,840	27.8%	4,802,309	27.9%	4,078,005	27.9%	3,746,457	27.9%
225	SHUTDOWN COOLING WATER SYSTEM	210,072	18.0%	774,664	18.0%	717,078	18.0%	666,612	18.0%
226	REACTOR CAVITY COOLING SYSTEM	940,052	19.0%	3,255,742	19.0%	2,945,179	19.0%	2,744,660	19.0%
227	REACTOR SERVICE SYSTEM	10,388,849	22.4%	13,869,694	22.4%	12,455,750	22.2%	11,388,029	22.2%
228	REACTOR CONTROL, PROTECTION & MONITORING	2,491,537	24.4%	4,104,651	24.4%	3,581,439	24.3%	3,306,211	24.3%
229	REACTOR PLANT MISCELLANEOUS	4,257,677	34.3%	4,496,177	32.1%	3,800,803	33.7%	3,492,082	33.3%
22	REACTOR PLANT EQUIPMENT	57,757,519	26.9%	153,741,948	27.4%	136,933,149	27.4%	126,107,285	27.4%
231	TURBINE GENERATOR & AUXILIARIES	13,807,500	35.0%	51,026,751	35.0%	46,207,240	35.0%	41,303,039	35.0%
233	MAIN & AUXILIARY STEAM SYSTEM	39,120	15.0%	39,120	15.0%	38,467	14.8%	38,860	15.2%
234	FEEDWATER & CONDENSATE SYSTEM	0	0.0%	0	0.0%	0	0.0%	0	0.0%
235	STARTUP & SHUTDOWN SYSTEM	0	0.0%	0	0.0%	0	0.0%	0	0.0%
236	TURBINE PLANT SAMPLING SYSTEM	0	0.0%	0	0.0%	0	0.0%	0	0.0%
237	ECA CONTROL, DATA & INSTRUMENTATION	589,404	18.4%	1,041,250	20.8%	972,999	20.5%	909,145	20.3%
23	TURBINE PLANT EQUIPMENT	14,436,024	33.6%	52,107,120	34.5%	47,218,706	34.5%	42,251,045	34.4%
241	SWITCHGEAR	338,434	15.6%	1,087,219	15.6%	1,069,671	15.6%	1,069,664	15.6%
242	STATION SERVICE EQUIPMENT	982,271	19.3%	2,849,132	21.5%	2,821,091	21.5%	2,815,376	21.5%
243	SWITCHBOARDS	554,682	15.0%	559,003	15.1%	557,709	15.1%	558,055	15.1%
244	PROTECTIVE EQUIPMENT	50,453	15.0%	100,898	15.0%	95,262	14.7%	97,149	15.3%
245	ELECTRIC STRUCTURES & WIRING CONTAINERS	1,004,311	25.7%	3,505,745	25.6%	3,248,334	25.5%	3,157,125	25.6%
246	POWER AND CONTROL WIRING	1,089,255	23.1%	3,994,263	23.0%	3,805,460	22.9%	3,753,303	23.0%
24	ELECTRIC PLANT EQUIPMENT	4,019,406	20.2%	12,096,260	21.7%	11,597,527	21.6%	11,450,672	21.6%

TABLE 5–12
MHTGR–GT/DC PLANT CONTINGENCIES BY ACCOUNT

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE

ACCOUNT NUMBER	ACCOUNT DESCRIPTION	LEAD MODULE		PROTOTYPE		REPLICA		TARGET	
		1992$	%	1992$	%	1992$	%	1992$	%
251	TRANSPORTATION AND LIFT EQUIPMENT	255,660	16.5%	358,636	16.6%	355,964	16.6%	354,780	16.6%
252	AIR, WATER, AND STEAM SERVICE SYSTEM	3,226,741	16.7%	3,861,054	16.6%	3,783,179	16.5%	3,757,936	16.6%
253	COMMUNICATIONS AND SECURITY EQUIPMENT	918,525	21.7%	918,525	21.7%	909,835	21.6%	911,678	21.9%
254	FURNISHINGS AND FIXTURES	476,495	25.0%	476,495	25.0%	475,525	25.0%	475,483	25.1%
25	MISCELLANEOUS PLANT EQUIPMENT	4,877,421	18.1%	5,614,710	17.8%	5,524,503	17.7%	5,499,877	17.9%
261	CIRCULATING AND SERVICE WATER PUMPHOUSE	35,841	15.0%	66,322	15.0%	61,987	14.7%	63,206	15.3%
262	ECA COOLING WATER SYSTEMS	511,987	15.0%	1,534,919	15.0%	1,515,441	14.9%	1,522,191	15.1%
263	CIRCULATING AND SERVICE WATER SYSTEM	713,194	15.0%	2,578,547	15.0%	2,466,399	14.8%	2,498,084	15.2%
26	HEAT REJECTION SYSTEM	1,261,022	15.0%	4,179,788	15.0%	4,043,827	14.9%	4,083,481	15.1%
2	TOTAL DIRECT COSTS	95,161,847	25.0%	255,237,576	26.5%	231,945,994	26.3%	215,647,530	26.2%
911	TEMPORARY CONSTRUCTION FACILITIES	6,795,317	21.0%	12,147,077	21.0%	9,881,504	21.0%	9,620,852	21.0%
912	CONSTRUCTION TOOLS AND EQUIPMENT	3,469,949	21.0%	6,202,763	21.0%	5,045,874	21.0%	4,912,776	21.0%
913	PAYROLL INSURANCE AND TAXES	4,048,274	21.0%	7,236,557	21.0%	5,886,853	21.0%	5,731,571	21.0%
2	PERMITS, INSURANCE, AND LOCAL TAXES	144,581	21.0%	258,448	21.0%	210,245	21.0%	204,699	21.0%
91	CONSTRUCTION SERVICES	14,458,121	21.0%	25,844,845	21.0%	21,024,477	21.0%	20,469,898	21.0%
920	REACTOR MODULE ENGINEERING AND SERVICES	5,411,000	25.0%	13,179,831	25.0%	7,524,581	25.0%	4,566,779	25.0%
921	PLANT ENGINEERING AND SERVICES	21,981,710	25.0%	27,640,528	25.0%	8,291,129	25.0%	8,229,927	25.0%
922	HOME OFFICE QUALITY ASSURANCE	316,057	25.0%	504,684	25.0%	276,371	25.0%	274,331	25.0%
923	HOME OFFICE PROJECT & CONSTRUCTION MGMT.	4,219,513	25.0%	5,917,158	25.0%	2,487,339	25.0%	2,468,978	25.0%
92	ENGINEERING AND HOME OFFICE SERVICES	31,928,281	25.0%	47,242,202	25.0%	18,579,419	25.0%	15,540,016	25.0%
931	FIELD OFFICE EXPENSES	855,700	21.0%	1,567,653	21.0%	1,392,780	21.0%	1,351,454	21.0%
932	FIELD JOB SUPERVISION	3,361,680	21.0%	6,158,638	21.0%	5,471,634	21.0%	5,309,285	21.0%
933	FIELD QUALITY ASSURANCE/QUALITY CONTROL	305,607	21.0%	559,876	21.0%	497,421	21.0%	482,662	21.0%
934	PLANT STARTUP AND TEST	1,589,158	21.0%	2,911,356	21.0%	2,586,591	21.0%	2,509,844	21.0%
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	6,112,146	21.0%	11,197,523	21.0%	9,948,425	21.0%	9,653,246	21.0%
941	PROJECT MANAGEMENT EXPENSES	2,118,925	15.0%	3,342,419	15.0%	1,616,963	15.0%	1,235,027	15.0%
942	FEES, TAXES, AND INSURANCE	1,496,250	15.0%	8,347,500	15.0%	8,670,000	15.0%	7,501,500	15.0%
943	SPARE PARTS AND CAPITAL EQUIPMENT	8,875,634	15.0%	10,596,441	15.0%	9,861,853	15.0%	8,948,138	15.0%
944	STAFF TRAINING AND STARTUP	5,293,704	15.0%	7,721,844	15.0%	6,462,291	15.0%	4,237,891	15.0%
945	GENERAL & ADMINISTRATIVE	2,443,240	15.0%	3,249,106	15.0%	2,674,061	15.0%	2,163,158	15.0%
94	OWNER'S COSTS	20,227,753	15.0%	33,257,310	15.0%	29,285,187	15.1%	24,085,714	15.0%
9	TOTAL INDIRECT COSTS	72,726,300	20.2%	117,541,879	20.0%	78,837,508	18.9%	69,748,874	19.0%
	TOTAL BASE CONSTRUCTION COST	167,888,147	22.7%	372,779,456	24.0%	310,783,501	24.0%	285,396,404	24.0%

TABLE 5–13(a)
MHTGR–GT/DC PROTOTYPE PLANT TOTAL CAPITAL COST COMPARISON

ACCOUNT NUMBER	ACCOUNT NAME	1992 M$ MHTGR GT/DC PLANT	1992 M$ MHTGR SC PLANT	% CHANGE TO GT/DC ESTIMATE	1992 M$ MHTGR GT/IC PLANT	% CHANGE TO GT/DC ESTIMATE
20	LAND & LAND RIGHTS	2.0	2.0	0.0%	2.0	0.0%
21	STRUCTURES & IMPROVEMENTS	134.7	157.4	−14.4%	167.8	−19.7%
22	REACTOR PLANT EQUIPMENT	560.7	522.9	7.2%	638.3	−12.2%
23	TURBINE PLANT EQUIPMENT	151.1	165.2	−8.5%	302.2	−50.0%
24	ELECTRIC PLANT EQUIPMENT	55.6	54.8	1.5%	55.9	−0.5%
25	MISCELLANEOUS PLANT EQUIPMENT	31.6	41.3	−23.5%	41.0	−22.9%
26	HEAT REJECTION SYSTEM	27.9	31.2	−10.6%	21.9	27.4%
2	TOTAL DIRECT COSTS	963.6	974.8	−1.1%	1,229.1	−21.6%
91	CONSTRUCTION SERVICES	123.1	141.8	−13.2%	148.5	−17.1%
92	HOME OFFICE ENGINEERING	189.0	176.6	7.0%	179.2	5.5%
93	FIELD OFFICE ENGINEERING	53.3	63.8	−16.5%	67.0	−20.4%
94	OWNER'S COSTS	221.7	179.6	23.4%	197.4	12.3%
9	TOTAL INDIRECT COSTS	587.1	561.8	4.5%	592.1	−0.8%
	BASE CONSTRUCTION COSTS	1,550.7	1,536.6	0.9%	1,821.2	−14.9%
	– $/KWe –	1,784	2,218	−19.5%	2,260	−21.0%
	CONTINGENCY	372.8	289.8	28.6%	392.1	−4.9%
	OVERNIGHT CONSTRUCTION COSTS	1,923.5	1,826.4	5.3%	2,213.3	−13.1%
	– $/KWe –	2,213	2,636	−16.0%	2,746	−19.4%
	INTEREST DURING CONSTRUCTION	384.6	358.0	7.4%	438.2	−12.2%
	TOTAL CAPITAL COST	2,308.1	2,184.4	5.7%	2,651.5	−13.0%
	– $/KWe –	2,656	3,153	−15.8%	3,290	−19.3%

TABLE 5–13(b)
MHTGR–GT/DC REPLICA PLANT TOTAL CAPITAL COST COMPARISON

ACCOUNT NUMBER	ACCOUNT NAME	1992 M$ MHTGR GT/DC PLANT	1992 M$ MHTGR SC PLANT	% CHANGE TO GT/DC ESTIMATE	1992 M$ MHTGR GT/IC PLANT	% CHANGE TO GT/DC ESTIMATE
20	LAND & LAND RIGHTS	2.0	2.0	0.0%	2.0	0.0%
21	STRUCTURES & IMPROVEMENTS	130.6	152.7	–14.5%	162.6	–19.7%
22	REACTOR PLANT EQUIPMENT	499.2	463.2	7.8%	566.8	–11.9%
23	TURBINE PLANT EQUIPMENT	137.0	156.5	–12.5%	281.6	–51.3%
24	ELECTRIC PLANT EQUIPMENT	53.7	52.8	1.7%	53.9	–0.4%
25	MISCELLANEOUS PLANT EQUIPMENT	31.2	40.8	–23.5%	40.5	–23.0%
26	HEAT REJECTION SYSTEM	27.2	30.5	–10.8%	21.3	27.7%
2	TOTAL DIRECT COSTS	880.9	898.5	–2.0%	1,128.7	–22.0%
91	CONSTRUCTION SERVICES	100.1	119.0	–15.9%	125.6	–20.3%
92	HOME OFFICE ENGINEERING	74.3	73.0	1.8%	74.6	–0.4%
93	FIELD OFFICE ENGINEERING	47.4	58.1	–18.4%	61.1	–22.4%
94	OWNER'S COSTS	194.5	164.3	18.4%	179.0	8.7%
9	TOTAL INDIRECT COSTS	416.3	414.4	0.5%	440.3	–5.5%
	BASE CONSTRUCTION COSTS	1,297.2	1,312.9	–1.2%	1,569.0	–17.3%
	– $/KWe –	1,493	1,895	–21.2%	1,947	–23.3%
	CONTINGENCY	310.8	251.1	23.8%	334.8	–7.2%
	OVERNIGHT CONSTRUCTION COSTS	1,608.0	1,564.0	2.8%	1,903.8	–15.5%
	– $/KWe –	1,850	2,257	–18.0%	2,362	–21.7%
	INTEREST DURING CONSTRUCTION	204.5	195.0	4.9%	239.7	–14.7%
	TOTAL CAPITAL COST	1,812.5	1,759.0	3.0%	2,143.5	–15.4%
	– $/KWe –	2,086	2,539	–17.8%	2,659	–21.6%

TABLE 5–13(c)
MHTGR–GT/DC TARGET PLANT TOTAL CAPITAL COST COMPARISON

ACCOUNT NUMBER	ACCOUNT NAME	1992 M$ MHTGR GT/DC PLANT	1992 M$ MHTGR SC PLANT	% CHANGE TO GT/DC ESTIMATE	1992 M$ MHTGR GT/IC PLANT	% CHANGE TO GT/DC ESTIMATE
20	LAND & LAND RIGHTS	2.0	2.0	0.0%	2.0	0.0%
21	STRUCTURES & IMPROVEMENTS	128.5	150.1	−14.4%	160.1	−19.7%
22	REACTOR PLANT EQUIPMENT	460.4	423.2	8.8%	523.0	−12.0%
23	TURBINE PLANT EQUIPMENT	122.7	155.7	−21.2%	263.0	−53.3%
24	ELECTRIC PLANT EQUIPMENT	53.0	51.9	2.1%	53.1	−0.2%
25	MISCELLANEOUS PLANT EQUIPMENT	30.8	40.2	−23.3%	39.9	−22.8%
26	HEAT REJECTION SYSTEM	27.0	30.2	−10.5%	21.1	28.0%
2	TOTAL DIRECT COSTS	824.4	853.2	−3.4%	1,062.2	−22.4%
91	CONSTRUCTION SERVICES	97.5	116.7	−16.4%	123.4	−21.0%
92	HOME OFFICE ENGINEERING	62.2	59.7	4.2%	62.5	−0.5%
93	FIELD OFFICE ENGINEERING	46.0	56.9	−19.1%	59.9	−23.2%
94	OWNER'S COSTS	160.6	132.0	21.7%	147.1	9.2%
9	TOTAL INDIRECT COSTS	366.3	365.2	0.3%	392.9	−6.8%
	BASE CONSTRUCTION COSTS	1,190.7	1,218.4	−2.3%	1,455.1	−18.2%
	– $/KWe –	1,370	1,759	−22.1%	1,805	−24.1%
	CONTINGENCY	285.4	231.9	23.1%	310.2	−8.0%
	OVERNIGHT CONSTRUCTION COSTS	1,476.1	1,450.3	1.8%	1,765.3	−16.4%
	– $/KWe –	1,699	2,093	−18.9%	2,190	−22.4%
	INTEREST DURING CONSTRUCTION	182.3	175.6	3.8%	215.9	−15.6%
	TOTAL CAPITAL COST	1,658.4	1,625.9	2.0%	1,981.2	−16.3%
	– $/KWe –	1,908	2,347	−18.7%	2,458	−22.4%

SECTION 6

MHTGR COMMERCIALIZATION AND INITIAL DEPLOYMENT COST SUMMARY

The MHTGR commercialization and initial deployment cost summary is provided on Table 6-1 for the MHTGR-SC, MHTGR-GT/IC, and MHTGR-GT/DC concepts. As presented herein, such costs include all front-end investments required to complete the design and technology development; build and operate the Lead Module of the Prototype Plant through design certification; expand the Prototype Plant to four modules; deploy an initial series of commercial plants through the Target Plant; and establish the associated infrastructure. It is noted that cost sharing arrangements for the various costs are not addressed. However, the organization and content of Table 6-1 are intended to serve as appropriate input for that purpose.

6.1 TOTAL DESIGN AND TECHNOLOGY DEVELOPMENT COSTS

The design and technology development activities required to achieve the FDA-1 (as presented in Figure 1-1) were discussed in Section 2 and cost estimates and cash flows were presented, including an allowance for NRC staff review, but excluding any interest costs. The total cost of the design and technology development is estimated to be $772, $874, and $1,013 million for the MHTGR-SC, the MHTGR-GT/IC, and the MHTGR-GT/DC concepts, respectively. Beyond FDA-1, there is the concluding licensing support effort to obtain the final FDA-2 and design certification. The extent of this effort will depend on the success of the Lead Module's performance in confirming the design and licensing bases. These costs, including engineering and licensing activities associated with the certification testing, operation, and NRC review are included under testing/certification costs included for the Lead Module and discussed below.

6.2 PROTOTYPE PLANT COSTS

The Prototype Plant costs are broken down for the Lead Module, which includes the common facilities for an expanded four module Prototype Plant, and the added costs for expansion. The design and licensing costs, the plant hardware/construction costs and owner's costs plus related interest costs on Table 6-1 are taken from Sections 3, 4, and 5 for the respective MHTGR concepts. Adjustments were made to the Prototype Lead Module and Prototype Plant capital costs to exclude the Lead Module factory FOAK costs which are presented separately, with contingency and interest, under infrastructure development costs in Table 6-1.

Initial fuel costs and fuel facility investments shown in Table 6-1 are consistent with the fuel cycle costs presented in Section 7. For the Lead Module, the initial core ($48.5 million) and the first reload ($24.1 million) fuel costs are included to cover the operating period through design certification. For the assumed operation during and after certification testing, the second refueling would not be scheduled for 9 months after certification. For the Prototype Plant expansion, only the cost of the initial cores for the three reactors is included. The initial core and reload costs identified are front-end capital commitments required of the owner, but are not included in the MHTGR capital cost

estimates presented in Sections 3, 4, and 5. These fuel expenditures are presented here to identify project/program cash flow requirements, however, it is important to note that these fuel expenditures are also included in the 30 year levelized fuel cycle costs presented in Section 7. Related interest costs have not been included for the initial core and 1st reload costs shown on Table 6-1.

6.3 TESTING/CERTIFICATION COSTS

In addition to capital and fuel cost commitments, the testing, operation, and certification costs related to performance documentation and safety testing to support design certification are included in the Lead Module cost category of Table 6-1. A summary breakdown and schedule of these costs are given in Table 6-2. As the fuel expenditures for the Lead Module have been identified separately, the certification/ operating costs have been presented as net of fuel to avoid double counting. The schedule is consistent with Figure 1-1 and the content is based on the steam cycle plant design. While modifications are needed for the MHTGR-GT concepts, Table 6-2 is considered representative for all three MHTGR concepts.

The cost estimate includes engineering costs for preparation of procedures, installation of instrumentation and data collection devices as required, performing the certification tests, and preparation of updated licensing documents (FSSAR-2). In addition, costs are estimated for operating the MHTGR Lead Module throughout the certification testing phase and a power production phase until receipt of design certification and conversion to private ownership. In addition, operating revenues were estimated during the test phase and power production phase at non-firm and firm rates, respectively, and used to offset fuel and O&M costs. Any related interest costs have not be included in the testing/certification costs.

The current design certification cost estimate builds on prior estimates (Reference 15) and additional input on the test plan documented in Reference 16. A 15 month test plan has been tentatively identified to run a series of 8 operability/accident tests. These tests are in addition to the normal tests performed during the 11 month startup and power ascension period included in the Lead Module construction schedule. All costs associated with startup, low power testing, and power ascension are included in the Lead Module capital cost estimate.

Testing costs include the engineering and equipment cost for preparing test procedures, designing and procuring test equipment, installation of the test equipment, conducting and monitoring the certification test program with the assistance of the Lead Module operating staff, and data reduction and analyses. A total of 34 man-years of engineering and 32 man-years of technician time were allocated for testing costs. Assuming a nominal cost of $200,000 per engineering man-year and $100,000 per technician man-year, including benefits, overhead, and fee, the total testing staff costs are estimated to be $10 million. An allowance of $10 million was included for equipment and instrumentation costs associated with the certification test program. In addition to special test equipment, instrumentation, data acquisition equipment, and computers required for the tests, the cost of designing and fabricating additional penetrations in primary system components is also included here. A 25% contingency is added to the

total testing estimate, recognizing the limited definition of the test program, requirements, and duration to achieve a 50% confidence estimate. The total testing costs are estimated to be $25 million with contingency.

Certification costs include the engineering and licensing staff costs to prepare the revised FSSAR to include the test program, data, and evaluations and interact with the NRC to obtain the FDA-2 and Certification. The focus of licensing efforts is assumed to shift from the standard plant design to the Lead Module and then shift back to the standard plant design after fuel load. A total of 60 man-years of engineering effort is assumed at $200,000 per man-year as an allowance-type estimate. A 25% contingency has also been added to achieve a 50% confidence estimate. The total engineering licensing costs are estimated to be $15 million with contingency.

A total of $8 million has been allocated for NRC staff review costs related to FDA-2 and certifying the MHTGR design. This represents nearly 35 man-years at the 1992 NRC average cost of $123 per hour. A 25% contingency was also added to the NRC staff costs resulting in a total estimate of $10 million for NRC staff review. Accordingly, the total estimated cost for testing and certification costs, excluding Lead Module operating costs, is estimated to be $50 million, including $10 million in contingency.

Operating costs during testing phase and following the power production phase through certification are based on the Lead Module annual O&M costs of $27.5 million documented in Reference 14. Under the assumed capacity factors listed in Table 2-2, the first refueling will occur towards the end of 2008 and the second refueling will occur in 2010 after conversion to private ownership. Accordingly, the capacity factor assumed for 2008 is limited although the certification test program is completed in 2007. If the 15 month test plan is executed as planned, commercial operation of the facility would begin 6 months into 2007. Operating revenues during the test phase are assumed to be based on non-firm electric prices of $25/MWhr due to the expected low unit capacity factors associated with the test phase. During the power production phase, a firm electric price of $50/MWhr is used which, together with assumed capacity factor increases, substantially reduces net operating costs. The total operating & maintenance costs for the 3.5 year test and power production period are $96.3 million. Electric power revenues of $113.7 million will provide net operating revenues through design certification of $17.4 million. The O&M cost estimate is a 50% confidence estimates and, thus, contingency has not been added.

The net testing/certification costs through design certification are estimated to be $32.6 million, excluding fuel costs, including $25 million for testing, $25 million for licensing, $96.3 million for 3.5 years of operating expenses, and a power production credit of $113.7 million.

6.4 INFRASTRUCTURE COSTS

In addition to the development and prototype plant costs, there are front-end infrastructure investments to design, build or modify related manufacturing facilities plus establish owner/operator support capability. Related interest costs are also included. While these investments will be amortized over their respective production runs, they are

included herein as they are part of the front-end cash flows required for the initial deployment of the MHTGR.

The most notable example is the fuel manufacturing facility which must be designed, licensed and manufactured, as opposed to modifying or expanding an existing facility. Accordingly, a long-lead time is required that results in the fuel facility investment being concurrent with the Prototype Plant capital investment schedule. Fortunately, the modular nature of the fuel manufacturing process lines allows manufacturing capacity to be expanded to meet the fuel supply schedule. However, with the related design and licensing costs, plus limited common facilities, the initial fuel plant, rated at 1000 blocks/year, to service the Lead Module requires an investment of approximately $72 million in 1992$. The addition of interest during construction increases the total investment to $89 million in constant 1992$. An initial expansion to 7000 blocks/year that supports the Prototype Plant and following commercial plants requires an additional $212 million, or $261 million including interest. Additional fuel production capacity would be required to support continued deployment of 6 reactors per year beyond 2014.

With regard to other components and systems, it has been assumed that existing manufacturing facilities have been modified and/or expanded to support MHTGR deployment. The most significant investment is associated with the vessel and heat exchangers which were assumed to be delivered from ASEA Brown Boveri Combustion Engineering Nuclear Power's (ABB/CENP) Chattanooga facility. To support the MHTGR-SC Lead Module, an investment of $14 million has been estimated, including contingency. The incremental investment to the support the MHTGR-SC Prototype Plant and additional commercial units is $136 million, which results in an annual throughput of 6 modules per year. Other manufacturing facility investments are required for the metallic reactor internals, assumed to be produced at ABB/CENP's Newington facility. These amount to $0.4 million and $52 million, including contingency, for the MHTGR-SC Lead Module and Prototype Plant, respectively. Other MHTGR-SC manufacturing facility investments required to produce Lead Module components are estimated to total $18 million including contingency and no additional MHTGR-SC Prototype Plant investments are projected. Interest costs increase the MHTGR-SC facility investment to $40 million for the Lead Module and $236 million for the Prototype Plant.

Lead module manufacturing facility investments increase to $49 and $40 million, including interest, for the MHTGR-GT/DC and MHTGR-GT/IC, respectively. Additional Prototype Plant facility investments for both MHTGR-GT concepts totals approximately $236 million with interest. The total factory FOAK costs for the MHTGR-GT vary due to changes in the scope of supply, however the major FOAK cost elements for vessels, heat exchangers, reactor core and internals are common to all MHTGR concepts. For a more detailed discussion of the factory FOAK costs specific to the MHTGR-SC, MHTGR-GT/IC, and MHTGR-GT/DC, see Sections 3.1.2, 4.1.2, and 5.1.2, respectively.

In addition, to the vendor/supplier related investment costs, there are owner/operator support related investment costs. These are primarily related to the formation and related training for a Central Operational Support Organization (COSO). The COSO concept is documented in Reference 17. For the present, an allowance of $25

million is included for the owner/operator infrastructure front-end costs, including related interest costs.

6.5 INITIAL COMMERCIAL DEPLOYMENT

For completeness, an initial series of commercial plants are included in Table 6-1, namely the Replica Plant through the Target Plant. Recall that the Target Plant is arbitrarily set to be the plant that exceeds 4500 MWe of installed capacity. Therefore, for the MHTGR-SC, six additional plants are included, whereas for the GT concepts, 5 additional plants are included. While the specific number of plants are arbitrary, the concept of an initial series of commercial plants is a practical consideration to warrant the infrastructure investments. No investor (owner, supplier, or government) is solely interested in building a one and only MHTGR.

6.6 FRONT-END CASH FLOWS

Total commercialization and initial deployment costs are estimated to be $14,004, $14,678, and $12,954 million for the MHTGR-SC, MHTGR-GT/IC and MHTGR-GT/DC concepts, respectively. Summary front-end cash flows for the major elements of investment required for design and technology development, the Lead Module, the Prototype Plant expansion and the infrastructure development for the three MHTGR concepts are presented in Tables 6-3(a), 6-3(b) and 6-3(c). It is noted that the projected cash flows reflect actual values for 1993, modestly constrained values for 1994, but unconstrained values thereafter.

It is also noted that the values in Table 6-3 represent the total cost without any consideration of the cost sharing arrangements between the government and the private sector or the prospects of international cooperation to offset a portion of such costs to the U.S.

TABLE 6–1
MHTGR COMMERCIALIZATION AND INITIAL DEPLOYMENT COST SUMMARY
(1992M$)

	SC	GT/IC	GT/DC
TECHNOLOGY	298	321	422
REFERENCE PLANT DESIGN & LICENSING			
THROUGH FDA–1	459	538	576
NRC STAFF REVIEW THRU FDA–1	15	15	15
SUBTOTAL DESIGN & LICENSING	474	553	591
TOTAL DESIGN & TECHNOLOGY DEVELOPMENT	772	874	1,013
PROTOTYPE LEAD MODULE			
DESIGN & LICENSING	167	172	190
PLANT HARDWARE/CONSTRUCTION	656	769	673
INITIAL CORE + 1ST RELOAD	73	73	73
OWNER'S COST	128	138	201
TESTING/CERTIFICATION COSTS (NET OF FUEL)	33	33	33
SUBTOTAL PROTOTYPE LEAD MODULE	1,056	1,184	1,169
PROTOTYPE PLANT EXPANSION			
DESIGN & LICENSING	84	89	91
PLANT HARDWARE/CONSTRUCTION	974	1,285	985
INITIAL CORES	105	105	105
OWNER'S COST	127	149	129
SUBTOTAL PROTOTYPE PLANT EXPANSION	1,290	1,628	1,310
TOTAL PROTOTYPE PLANT	2,346	2,812	2,479
INFRASTRUCTURE DEVELOPMENT			
FUEL FACILITIES			
PROTOTYPE LEAD MODULE	89	89	89
INITIAL EXPANSION	261	261	261
MANUFACTURING FACILITIES			
PROTOTYPE LEAD MODULE	40	49	40
INITIAL EXPANSION	236	236	237
OWNER/OPERATOR SUPPORT	48	50	50
SUBTOTAL INFRASTRUCTURE DEVELOPMENT	674	685	678
TOTAL COST THROUGH PROTOTYPE PLANT	3,792	4,371	4,170
REPLICA THROUGH TARGET PLANTS	10,212	10,307	8,784
TOTAL COST THROUGH TARGET PLANT	14,004	14,678	12,954

TABLE 6–2
MHTGR CERTIFICATION COST SUMMARY

		FY00	FY01	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09	Total
Testing												
Staff				0.5	1.0	2.0	2.0	2.0	1.5	1.0	0.0	10.0
Equipment						4.0	5.0	1.0				10.0
Contingency	25%	0.0	0.0	0.1	0.3	1.5	1.8	0.8	0.4	0.3	0.0	5.0
Subtotal Testing		0.0	0.0	0.6	1.3	7.5	8.8	3.8	1.9	1.3	0.0	25.0
Certification												
Engineering/Licensing				0.0	0.5	1.5	2.5	2.5	2.0	2.0	1.0	12.0
Contingency	25%	0.0	0.0	0.0	0.1	0.4	0.6	0.6	0.5	0.5	0.3	3.0
Sutotal Certification		0.0	0.0	0.0	0.6	1.9	3.1	3.1	2.5	2.5	1.3	15.0
Subtotal Testing & Certification		0.0	0.0	0.6	1.9	9.4	11.9	6.9	4.4	3.8	1.3	40.0
NRC Costs												
Staff						0.4	0.9	2.1	2.3	1.4	0.9	8.0
Contingency	25%	0.0	0.0	0.0	0.0	0.1	0.2	0.5	0.6	0.4	0.2	2.0
Subtotal NRC Costs		0.0	0.0	0.0	0.0	0.5	1.1	2.6	2.9	1.8	1.1	10.0
Total Testing & Certification		0.0	0.0	0.6	1.9	9.9	13.0	9.5	7.3	5.5	2.4	50.0
Lead Module Operating Costs												
Months Operating		0	0	0	0	0	0	9	12	12	9	
O&M		0.0	0.0	0.0	0.0	0.0	0.0	20.6	27.5	27.5	20.6	96.3
Fuel		0.0	0.0	0.0	0.0	0.0	0.0	8.6	17.1	22.8	10.6	59.1
Subtotal Operating Costs		0.0	0.0	0.0	0.0	0.0	0.0	29.2	44.6	50.3	31.2	155.3
Lead Module Revenues												
Plant Capacity Factor		0.0	0.0	0.0	0.0	0.0	0.0	30%	45%	60%	75%	
Electricity Price ($/MWhr)							25.0	25.0	25.0	50.0	50.0	
Credit For Revenues		0.0	0.0	0.0	0.0	0.0	0.0	8.5	17.0	45.5	42.6	113.7
Contingency	0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal Operating Revenues		0.0	0.0	0.0	0.0	0.0	0.0	8.5	17.0	45.5	42.6	113.7
Net Operating Costs		0.0	0.0	0.0	0.0	0.0	0.0	20.7	27.6	4.9	−11.4	41.7
Certification/Operating Costs												
TOTAL		0.0	0.0	0.6	1.9	9.9	13.0	30.2	34.8	10.4	(9.0)	91.7
NET OF FUEL COSTS		0.0	0.0	0.6	1.9	9.9	13.0	21.6	17.7	(12.5)	(19.6)	32.6

TABLE 6–3(a)
MHTGR–SC FRONT–END CASH FLOWS

MHTGR–SC	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Totals
Design & Technology	32.8	64.6	102.2	126.8	134.1	109.2	85.6	61.9	28.2	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	747.4
Lead Module	0.0	0.0	0.9	0.9	1.7	2.8	12.7	23.4	41.8	115.2	217.3	261.7	232.9	142.4	24.9	(2.9)	(19.6)	0.0	0.0	0.0	1,056.1
Prototype Plant Expansion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.5	49.8	191.4	425.9	408.5	192.0	1,290.1
Infrastructure	1.2	2.0	2.5	3.0	3.0	3.0	3.0	16.3	41.2	48.7	34.1	3.3	4.2	36.0	110.3	137.8	159.4	64.7	0.0	0.0	673.7
Subtotal	34.0	66.6	105.6	130.7	138.8	115.0	101.3	101.6	111.2	165.9	251.4	265.0	237.1	178.4	157.7	184.7	331.2	490.6	408.5	192.0	3,767.3

TABLE 6–3(b)
MHTGR–GT/IC FRONT–END CASH FLOWS

MHTGR–GT/IC	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Totals
Design & Technology	32.1	68.3	113.3	144.6	153.5	126.7	96.2	72.4	34.7	9.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	851.0
Lead Module	0.0	0.0	1.0	1.0	1.9	3.1	14.5	26.5	47.5	129.4	243.7	293.6	261.9	157.7	24.9	(2.9)	(19.6)	0.0	0.0	0.0	1,184.2
Prototype Plant Expansion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.5	68.5	260.4	534.0	513.7	220.8	1,627.9
Infrastructure	1.2	2.0	2.5	3.0	3.0	3.0	3.0	17.5	44.1	51.6	37.9	3.3	4.2	36.0	110.5	137.9	159.6	64.7	0.0	0.0	685.0
Subtotal	33.3	70.3	116.8	148.6	158.4	132.8	113.7	116.4	126.3	190.2	281.6	296.9	266.1	193.7	165.9	203.5	400.3	598.7	513.7	220.8	4,348.1

TABLE 6–3(c)
MHTGR–GT/DC FRONT–END CASH FLOWS

MHTGR–GT/DC	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Totals
Design & Technology	31.9	68.5	129.3	151.7	165.5	154.0	130.6	92.6	45.9	16.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	986.2
Lead Module	0.0	0.0	1.0	2.9	4.0	9.5	22.6	30.3	52.1	136.4	204.5	272.3	254.7	176.4	24.9	(2.9)	(19.6)	0.0	0.0	0.0	1,169.1
Prototype Plant Expansion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.5	43.4	195.3	433.7	431.7	185.6	1,310.2
Infrastructure	1.2	2.0	2.5	3.0	3.0	3.0	3.0	16.4	41.4	49.5	36.0	3.3	4.2	36.1	110.7	138.1	159.7	64.7	0.0	0.0	677.8
Subtotal	33.1	70.5	132.8	157.6	172.5	166.5	156.2	139.3	139.4	202.1	240.5	275.6	258.9	212.5	156.1	178.6	335.4	498.4	431.7	185.6	4,143.3

SECTION 7

BUSBAR GENERATION COSTS AND COMPARISONS

7.1 MHTGR LEVELIZED CAPITAL COSTS

The MHTGR capital costs presented and described in Sections 3, 4 and 5 for the MHTGR-SC, MHTGR-GT/IC, and MHTGR-GT/DC, respectively were levelized over the assumed 30 year analysis period using the utility based fixed charge rate as developed from the financial parameters shown in Table 1-6 and other related parameters in Table 1-7. The 30 year levelized fixed charge rate establishes a uniform cash flow over the 30 year economic life of the plant sufficient to cover return of capital (depreciation), return on capital (profit), property taxes @ 2% per year, interim capital replacement investments of 0.5% of initial capital costs and income tax effects. The fixed charge rate varies depending on the ratio of total interest during construction to total capital cost for the concepts and the year of deployment. No real escalation on capital, materials, and labor was included, per the Reference 2 groundrules. This variation in the fixed charge rate results from tax regulations that prohibit depreciation, for tax purposes, of the interest charges based on equity financing.

By multiplying the fixed charge rate calculated above and the total capital cost estimated for each MHTGR concept, the 30 year levelized annual payments are calculated. These levelized capital costs provide the equivalent return of the actual cash flows associated with the facility which are higher than the levelized cash flows during the early years due to the depreciating capital investment over the economic life of the plant.

7.2 MHTGR FUEL CYCLE COSTS

The fuel design, fuel cycle facilities, and fuel cycle costs are identical for all three MHTGR design concepts except for the mills per kilowatt-hour evaluation where net thermal efficiencies adjust the busbar fuel cycle costs presented in Section 7.6. Actual cash flows and fuel cycle costs in dollars per million BTU ($/MMBTU) are the same for each design and are presented in this Section. The fuel cycle costs presented are based on 30 year operation with 18 month operating periods between refuelings. Costs for periodic reflector block and control rod replacement costs are included in the operations and maintenance expenses reported in Section 7.3.

The reference MHTGR fuel cycle is a once through, low enriched Uranium (LEU) cycle. Fissile particle enrichment is 19.9% and 10.2% tails. Average enrichment is 15.5% and burnup is designed to be 121,000 MWt-day/TN heavy metal. No reprocessing of spent fuel blocks is assumed and all spent fuel waste disposal costs are assumed to be covered by the 1 mill/kWhr Waste Policy Act charge. Spent fuel blocks would be shipped in transfer casks, without processing or reduction, to government operated waste repositories.

In accordance with the Reference 2 groundrules, the nuclear fuel cycle cost input assumptions are presented in Table 1-8. Spent fuel disposal costs are included at 1 mill/kWhr in accordance with the Waste Policy Act provisions for government operation of spent fuel repository sites. Building space has been provided on-site in the capital cost estimate for up to 10 years of spent fuel storage. However, on the expectation that waste repositories will be available to receive MHTGR spent fuel generated after 2010, the spent fuel casks required for long term on-site spent fuel storage are not currently included in the fuel cycle, capital, or O&M cost estimates. If waste repositories are not assumed to be available to receive MHTGR spent fuel, additional O&M costs would be projected to cover the costs of casks for temporary on-site spent fuel storage.

Lead Module fuel load is scheduled per Figure 1-1 to occur in 2005 and the initial core will be supplied by a 1,000 block/year pilot plant. The initial design, licensing, proof testing, and facility construction costs are estimated to be $72 million, a 50% confidence estimate. The pilot plant fuel fabrication costs are estimated to be $39,400/block. The addition of a new 6,000 block/year fuel fabrication line at a cost of $212 million is required to supply the total fuel requirements for the Prototype Plant and initial commercial plants. As required, the 6,000 block/year facility will be expanded to 12,000 blocks/year which is adequate to produce initial cores and reloads for up to 42 reactors or more than 10 Reference MHTGR power plants. Future MHTGR deployment leads to construction and operation of a larger 24,000 block/year fuel fabrication facilities which reduces average MHTGR fuel fabrication costs to $12,900/block. Table 7-1 summarizes the MHTGR fuel fabrication costs for the MHTGR Lead Module, Prototype Expansion, Replica, and Target Plants.

Table 7-2 presents the 30 year levelized MHTGR fuel costs in $/MMBTU for the Lead Module, Prototype, Replica, and Target Plants. The spent fuel disposal cost presented in Table 7-2 is based on the MHTGR-SC heat rate of 8,868 BTU/kWhr. As noted, the higher efficiency (lower heat rate) of the MHTGR-GT concepts increases the $/MMBTU spent fuel disposal cost based on the 1 mill/kWhr Waste Policy Act assessment. As the MHTGR-GT concepts produce less radioactive waste per electric kilowatt-hour and much less than current LWR technology, the Waste Policy Act assessment seems inappropriate for advanced technologies. It would be more logical to assess waste costs on the thermal energy generated by the reactor. On this basis, all three MHTGR concepts would be assessed an equal amount for spent fuel disposal, which is fitting since each concept generates the same amount of spent fuel. Based on the LWR technology and its' heat rate of 10,200 (Reference 9), the MHTGR's equivalent spent fuel disposal cost on a thermal basis would be less than $0.100/MMBTU. Since the Waste Policy Act never intended to penalize more efficient nuclear technologies, the method of assessing spent fuel disposal costs should be revisited for the more efficient nuclear technologies.

7.3 MHTGR OPERATING AND MAINTENANCE COSTS

MHTGR O&M costs have been estimated in detail and are documented in Reference 14. The non-fuel operating and maintenance (O&M) costs are estimated for the 30 year economic life of the plant. The estimated O&M costs vary between the MHTGR-SC, MHTGR-GT/IC, and the MHTGR-GT/DC due to the fundamental changes in plant design

and the amount of equipment. The MHTGR-GT/DC offers a more simplified, compact plant design. The elimination of steam turbine and associated equipment is expected to reduce maintenance requirements for the MHTGR-GT concepts relative to the MHTGR-SC. Table 7-3 provides a summary of MHTGR Prototype Plant O&M costs in millions of dollars per year and mills/kWhr. Table 7-4 provides a similar comparison of the Replica Plants. Estimates of MHTGR Target Plant O&M costs are summarized on Table 7-5.

Certain O&M costs, such as those for materials and supplies, are dependent on the amount of energy generated by the plant. These variable O&M costs, which include the periodic replacement of control rods and reflector blocks, are added to the fixed costs to arrive at total O&M costs. Fixed costs include on-site and off-site staff costs, pensions, benefits, fees, insurance and Administrative and General costs. The plant operating staff salaries used to determine the on-site staff costs were defined in Reference 2. In accordance with the Reference 2 groundrules, 10% has been added to staff salaries to cover payroll taxes and unemployment insurance and 25% has been added to account for pension and benefits. An additional 1% was included in the MHTGR pension and benefits entry to account for premium time paid to shift employees for holiday work, night shift, and certain weekend shifts. Personnel costs dominate the estimated MHTGR O&M cost estimates. On-site staff salaries, payroll taxes, pensions and benefits and associated administrative and general costs vary from over 52% of total O&M costs for the MHTGR Prototype Plants to 46% for the MHTGR-GT/DC Target Plant.

The staff size projected for the MHTGR is significantly lower than current U.S. power plants, which NUMARC reports (Reference 18) employs an average of 975 on-site. The European nuclear power plant average staff size is 540. In the U.S., efforts are underway to reduce O&M costs and some of the unnecessary requirements that have increased staff requirements. The MHTGR will benefit from these efforts but also benefits from standardization and certification of the MHTGR design, enhanced safety performance, and substantial reductions in equipment important to safety. Current U.S. experience deals with largely unique designs at each site, which continue to evolve to meet changing regulatory requirements and improve performance. The MHTGR's enhanced safety features permit substantial reductions in technical specifications and the amount of equipment subject to regulatory purview and reporting requirements. Through standardization and the availability of the Central Operational Support Organization (COSO), interface with the NRC for any future modifications may be designed and amortized over an entire class of MHTGR plants rather than requiring on-site staff at each plant.

Although the MHTGR Prototype Plants carry a significantly larger staff in the economic evaluation than the corresponding Replica or Target Plants, there is no technical reason why the eventual Prototype Plant operating staff would not be the same as the Target Plant. The higher staff allowance for the Prototype and Replica Plants reflects some conservatism and a judgement that in the early years a larger staff will be required for the initial testing and shakeout period.

7.4 MHTGR DECOMMISSIONING COSTS

The Reference 3 DOE guidelines provide a default equation for calculating decommissioning cost estimates. The default values are based on the NRC minimum prescribed decommissioning costs developed by PNL. Separate costs as a function of unit thermal output were prescribed by PNL for PWRs and BWRs. These costs, when increased by inflation since 1986 and also by the estimated cost of dismantlement, result in the values shown. For reactor types other than BWRs or PWRs, it is stated that an average value should be used. The cost equations applicable in the range of 1200 MWt to 3400 MWt are:

PWR: Cost (million $) = 145 + 0.015(P-1200)
BWR: Cost (million $) = 185 + 0.015(P-1200)
Other: Cost (million $) = 165 + 0.015(P-1200)

where P = block thermal power, MWt. Accordingly the MHTGR decommissioning costs would be estimated to be $174 million for the 1800 MWt MHTGR power plant according to the guideline formula. At this time there is no basis to differentiate the decommissioning costs among the three MHTGR concepts and thus the same value was used for all. Funds for decommissioning are collected over the 30 year assumed economic life and invested in an external sinking fund of high-grade tax free municipal funds yielding a nominal 7%/year or 2% above inflation. Using the above cost and methodology, decommissioning contributes less than 1 mill/kWhr to busbar generating costs and, therefore, doubling the estimated cost noted above would increase busbar generation costs by less than 1 mill/kWhr.

Estimates for decommissioning have varied widely in published literature from $100 million to several hundred million. A MHTGR specific estimate was developed during 1993 by Bechtel (Reference 19) for the MHTGR-SC using actual quantities and commodities from the cost estimate. This cost estimate examined three alternative decommissioning scenarios including a complete removal of all construction material and return to original "green-field" condition, removal of all radioactive waste and construction material to 3 feet below grade, and removal of all construction material to 3 feet below grade and entomb low level waste in-situ. Based on the quantity takeoffs and a defueling schedule of 2 years and decommissioning and decontamination schedule of nearly 4 years, the "green-field" alternative was estimated to cost $247 million. Alternative 2, which reduces the schedule and cost of decommissioning by leaving all non-radioactive structural material 3 feet below grade, is estimated to cost $194 million. Alternative 3, which uses the structures 3 feet below grade for in-situ storage of low level waste, is the least costly alternative at $124 million. For the purposes of busbar cost comparisons, Alternative 2 will be used in the MHTGR cost estimates even though it is acknowledged to be higher than the default guideline. Decommissioning costs for the MHTGR-GT designs were estimated to be $260 million, $199 million, and $120 million for Alternatives 1, 2, and 3, respectively.

7.5 MHTGR PERFORMANCE CHARACTERISTICS

The MHTGR-GT performance has been evaluated for the EPRI standard hypothetical East/West Central site, as described in Appendix F, Reference 3. This site description, typical of a Midwest U.S. site specifies a 60°F dry bulb and 52°F wet bulb temperature for determining plant thermal efficiencies. These temperatures represent average annual temperatures and are consistent with the performance ratings published in References 8 and 9 and used for the alternative plants presented in Sections 7.7 and 7.8. These temperature conditions are a change from the design point temperatures used in prior MHTGR cost estimate reports. This is significant for the MHTGR-GT concepts which are much more sensitive to the heat rejection temperature. The net plant efficiencies, based on the specified average annual temperatures, are estimated to be 44.8% for the MHTGR-GT/IC, and 48.3% for the MHTGR-GT/DC.

The MHTGR-SC performance and cost estimate is based on equipment sizing for a maximum case of 82°F wet bulb while maintaining a 3.5" Hg condenser pressure. The Reference 3 guidelines specify equipment sizing at 75°F wet bulb and permit optimization of the plant performance at same cooling water rate as used at the maximum design case instead of varying cooling water flow to maintain condenser pressure. Given the above, the MHTGR-SC case presented has been penalized slightly with regard to capital cost and performance relative to the guideline conditions. The capital cost penalty was estimated to be approximately $1 million in direct cost and the performance improvement was estimated to be 0.6%.

The Lead Module and Prototype Plant levelized fuel cycle cost evaluation assumes an average capacity factor of 78% over the 30 year life. The Replica Plant fuel cycle evaluation assumes an average capacity factor of 81% and the Target Plant assumes a capacity factor of 84% which is consistent with the Utility/User requirements, Reference 11. These capacity factors were specified as groundrules (Reference 2) for evaluation. The fuel cycle design provides added capability to ensure that these capacity factor targets can be met, that is, the capacity factor is not limited by fuel capabilities.

The MHTGR-SC availability and capacity factor were recently reevaluated and documented in Reference 20. The reported MHTGR scheduled annual outages represent a 6.0% unavailability and forced outages were estimated to represent a 7.4% unavailability, allowing a total plant outage rate of 13.4%. The resulting 86.6 potential capacity factor is reduced by 1.6% to account for maintenance outages and outages requested by regulatory and institutional requests. The overall capacity factor for the MHTGR-SC is estimated to be 85%. The MHTGR design is now based on an 18 month refueling cycle.

The current MHTGR configuration of four reactors and four turbines was selected, in part, due to the improved availability of small turbomachines as documented in Reference 5. Steam turbine availability data suggests a strong relationship between steam turbine output and turbine availability. North American Electric Reliability Council (NERC) data shows that 200 MWe turbines have an availability of 93% vs. 88% for 600 MW(e) turbines. Data accumulated by Utility Power Corporation (UPC) and SWEC identified smaller gains for the smaller steam turbines, on the order of 1.5%. The average of the data indicated that 200 MW(e) turbines had an availability of 91.5%, 2.5% higher

than 600 MW(e) machines. Multiple turbines on-site permits station response to part load requirements with higher heat rates, by operating some units at full load while others are shutdown or at part load. For these reasons, the 4(1x1) MHTGR capacity factor was estimated to be nearly 4 points higher than a 4 reactor MHTGR-SC with a single large 760 MW(e) gross turbine. For the reasons noted above, the MHTGR 4(1x1) configurations is expected to have a capacity factor advantage over 600 MW(e) nuclear and fossil alternatives and an even greater advantage over 1200 MW(e) alternatives with single steam turbines.

Although gas combustion turbines have maintained availability advantages over gas steam turbines, 91% vs. 85% unit availability per North American Electric Reliability Council (NERC) data from 1987 through 1991, no relative advantage has been included in the reference MHTGR cost evaluation and comparisons. Preliminary studies indicate that the MHTGR-GT concepts are capable of a 89% capacity factor, nearly 3% higher than that evaluated for the MHTGR-SC. The relative advantages of the MHTGR concepts will be evaluated in sensitivity studies presented in Section 8.

Although higher MHTGR availabilities and capacity factors have been evaluated for the MHTGR, the reference economic evaluations were based on the default capacity factors of 78% for the Prototype Plant, 81% for the Replica Plant, and 84% for the Target Plant. This approach is expected to be somewhat conservative and allows for improvements in plant capacity factor through learning and experience and accounts for testing of the Lead Module for certification purposes. There is no reason to believe that the Prototype Plant will actually perform any differently than the Target Plant after the initial startup, testing and checkout period. The higher capabilities of the MHTGR were also evaluated as part of sensitivity studies presented in Section 8.

7.6 MHTGR BUSBAR OPERATING COSTS

Table 7-6 presents the 30 year levelized busbar generation costs for the MHTGR-SC, MHTGR-GT/IC, and MHTGR-GT/DC Prototype Plants. The capital costs reflect the initial FOAK costs associated with the Lead Module and initial learning applied to modules 2, 3, and 4. MHTGR Replica Plant busbar generation costs are presented in Table 7-7 and MHTGR Target Plant costs are presented in Table 7-8.

MHTGR-SC Replica Plant busbar generation costs are 11.6 mills/kWhr lower than the MHTGR-SC Prototype Plant and 6.4 mills/kWhr higher than the Target Plant, reflecting the elimination of FOAK costs, learning applied, higher capacity factor, and shorter construction schedule. The MHTGR-GT/IC Replica is 12.4 mills/kWhr lower than the Prototype Plant and 6.2 mills/kWhr higher than the Target Plant. The MHTGR-GT/DC Replica is 10.7 mills/kWhr lower than the Prototype and 5.7 mills/kWhr higher than the Target Plant.

Busbar O&M costs for the Prototype and Replica Plants reflect the larger operating staff, consistent with deployment of a new technology, but carried for the entire 30 year life. After the initial shakeout and successful operation of the Prototype and Replica Plants, O&M staffing levels are projected to approach those estimated for the Target Plants, reducing 30 year levelized Prototype Plant operating costs. The O&M estimates

are shown to vary by 2 mills/kWhr from Prototype to Target Plant so the impact of such an adjustment would be minor.

MHTGR fuel costs reflect the deployment of fuel cycle facilities described in Section 7.2 which follows the MHTGR deployment scenario identified in Table 1-1. If the MHTGR deployment scenario is stretched out and/or slowed, higher fuel cycle costs would be incurred over the 30 year economic life of all the MHTGR plants presented.

The MHTGR-SC and MHTGR-GT/DC Target Plants have similar capital costs even though the MHTGR-GT/DC generates 25% more power and has less equipment. The MHTGR-GT/IC is more capital intensive and has the highest evaluated unit capital cost of $2,457/kWe and generates 16% more power than the MHTGR-SC. The evaluated capital contributions to busbar costs are 30.2 mills/kWhr for the MHTGR-SC, 31.6 mills/kWhr for the MHTGR-GT/IC, and 24.6 mills/kWhr for the MHTGR-GT/DC.

The reduced staff sizes which were estimated for the MHTGR-GT concepts reduces annual O&M costs and the advantage is compounded by the increased power generation. Levelized busbar O&M costs are estimated to be 8.0 mills/kWhr for the MHTGR-SC, 6.2 mills/kWhr for the MHTGR-GT/IC, and 5.2 mills/kWhr for the MHTGR-GT/DC. The relative O&M busbar cost advantage of the MHTGR-GT/DC over the MHTGR-SC may be broken down into two components, a 20% reduction due to increased power output and a 17% reduction in annual O&M costs. The MHTGR-GT/IC maintains a 14% advantage in power output and a 9% reduction in annual O&M costs.

The same MHTGR reactor and fuel is used to power all three MHTGR concepts and the annual fuel costs are identical. Again the increased power output of the MHTGR-GT/DC causes a 20% reduction in busbar fuel costs, whereas the MHTGR/IC maintains a 14% advantage. Due to the 1 mill/kWhr Waste Policy Act charge for spent fuel disposal, the MHTGR-GT concepts are assessed higher fuel costs on a $/MBTU basis.

MHTGR decommissioning costs have been estimated by Bechtel (Reference 19) for three alternative decommissioning scenarios. The Alternative 2 scenario, which removes all low level radioactive waste but leaves all other construction materials below -3 feet in place. The estimated decommissioning costs for the MHTGR-SC is $194 million and for the MHTGR-GT concepts is $199 million which requires annual charges of $5.2 million and 5.4 million, respectively. The busbar costs range from 1.0 mills/kWhr for the MHTGR-SC to 0.8 mills/kWhr for the MHTGR-GT/DC.

The initial MHTGR deployment schedule identified in Figure 1-1 and Table 1-1 projects Target Plant deployment by 2016. The corresponding busbar generation costs for the 30 year operating life are 50.3 mills/kWhr for the MHTGR-SC, 48.4 mills/kWhr for the MHTGR-GT/IC, and 39.7 mills/kWhr for the MHTGR-GT/DC. For the busbar cost evaluation, the MHTGR-GT/DC holds a 21% advantage over the MHTGR-SC and a 17% advantage over the MHTGR-GT/IC. The relative advantage of the GT concepts would increase further if the relative availability/capacity factor advantages (3%) of the MHTGR-GT concepts were to be incorporated in the evaluation. These advantages will be addressed in the sensitivity evaluations included in Section 8.

7.7 ALTERNATIVE POWER PLANT BUSBAR COST

Alternative fossil plant performance and capital and operating cost data were included in the Reference 2 groundrules for comparison with the MHTGR cost estimate. The data were based on data originally included in the USCEA Study (Reference 9) for a natural gas combined cycle combustion turbine (CCCT) and a pulverized coal (PC) plant. These plants are commercially available technology. Adjustments were made to the AFUDC calculation for the PC plant and the fuel cost estimates were based on the prices and escalation rates included in Table 1-9, as specified in the groundrules. Table 7-9 identifies the high, reference, and low busbar generating cost cases for the natural gas CCCT plant. The reference CCCT case presented reflects the capital and operating costs presented in the USCEA Study, and the Table 1-9 fuel cost assumptions of $2.33/MMBTU in 1992 and 2.2% real escalation. The evaluated busbar cost for the reference CCCT case is 48.9 mills/kWhr, consisting of 7.5 mills/kWhr capital, 2.1 mills/kWhr operating, and 39.3 mills/kWhr for fuel. The CCCT provides a low capital cost, high efficiency option whose economic performance is heavily dependent on natural gas prices. Under the reference scenario, more than 80% of the levelized busbar costs are fuel costs.

The high CCCT case reflects a 10% higher capital cost, a 10% higher O&M cost, and a 10% higher initial natural gas price with 3.3% real escalation. The low CCCT case reflects 10% lower capital and operating costs, 10% lower initial natural gas price with a 1.1% real escalation. These high and low cases show the volatility of the CCCT to changes in fuel price assumptions. The high case represents a 55% increase in busbar generation costs over the reference CCCT case, consisting of 53% fuel, 1% capital, and less than 1% O&M. The low CCCT case represents a 34% reduction in busbar generation costs, over 32% of which is due to fuel.

Table 7-10 presents the reference, high and low scenarios for the pulverized coal plant. The reference PC case reflects the capital and operating costs presented in the USCEA Study, with a small increase in AFUDC, and the Table 1-9 fuel cost assumptions of $1.45/MMBTU in 1992 and 1.0% real escalation. The evaluated busbar cost for the reference PC case is 48.9 mills/kWhr, consisting of 19.4 mills/kWhr capital, 9.1 mills/kWhr operating, 20.3 mills/kWhr for fuel, and 0.1 mills/kWhr for decommissioning. The PC provides a higher capital cost, moderate efficiency option whose economic performance is more balanced between fuel prices and capital costs. Under the reference scenario, more than 40% of the levelized busbar costs are fuel costs, nearly 40% capital and nearly 20% are O&M costs.

The high PC case reflects a 10% higher capital cost, a 10% higher O&M cost, and a 10% higher initial coal price with 1.5% real escalation. The low PC case reflects 10% lower capital and operating costs, 10% lower initial coal price with a 0.5% real escalation. These high and low cases show the same volatility of the PC to changes in fuel price assumptions. The high case represents 19% increase in busbar generation costs over the reference PC case, consisting of 13% fuel, 4% capital, and less than 2% O&M. The low PC case represents a 16% reduction in busbar generation costs, over 10% due to fuel. The pulverized coal O&M costs includes a $500/ton Sulfer tax consistent with the USCEA Study assumptions which adds about 1 mill/kWhr to the busbar costs.

The variation in the high, reference, and low cases presented for the natural gas CCCT and pulverized coal plants in Tables 7-9 and 7-10, respectively, are reasonable when one considers regional cost differences and widely varying fuel price projections. More discussion on fuel price uncertainty and it's impact on evaluated costs is contained in Section 8.1 The CCCT option presented is currently of high interest to utilities and IPPs and with good reason. With current natural gas prices low and attractive contracts for delivery available, the CCCT is often the lowest generation cost option in the early years of operation with the added benefits of being lower capital cost and minimum lead time relative to other power generation options. As natural gas prices increase, the CCCT may gradually be converted from baseload to load following or peaking operation and remain a cost effective contributor to the electric grid. Improvements in CCCT efficiency are already in progress and are likely to be deployed in the future. Thermal efficiencies up to 54% have been announced recently (Reference 21) and DOE's draft program plan for advanced gas turbine systems identifies a goal of 60% (Reference 22). Introduction of more efficient turbines will maintain CCCT competitiveness at higher natural gas prices.

7.8 COMPARISON OF MHTGR COST WITH ALTERNATIVE POWER PLANTS

Table 7-11 provides a comparison of the three MHTGR concepts with the pulverized coal (PC) and natural gas (CCCT) options discussed in Section 7.7. The breakdown of the busbar costs is presented graphically in Figure 7-1. In addition, an Advanced Light Water Reactor (ALWR) and integrated coal gasification combined cycle (IGCC) plant were added from the USCEA Study (Reference 9). All cases presented are for the reference fuel cost scenarios as presented in Tables 1-8 and 1-9. The ALWR and IGCC cases were also adjusted for AFUDC to be consistent with approach identified in Reference 3. For the 2016 startup, all options are in the competitive range, given the amount of uncertainty in estimating operating costs between the years 2016 and 2045.

The MHTGR-GT/DC Target Plant provides an advantage of nearly 18% over the three fossil options presented. The MHTGR-GT/IC Target Plant is competitive with the fossil options and the MHTGR-SC is marginally higher in evaluated busbar generation costs. Clearly the MHTGR-GT/DC holds a significant incentive to pursue and offers the opportunity to pursue higher temperature applications of nuclear power. The ALWR plant cost estimate is presented as a point of discussion only as updated estimates for the ALWR consistent with the Reference 3 Advanced Reactor Cost Estimating Guidelines were not available for a direct comparison. Based on GCRA's understanding of the labor rates, productivities, and plant contingencies applied to the original ALWR cost estimate, an updated capital cost estimate consistent with Reference 3 groundrules and assumptions would be higher than that reported here unless performance improvements or other cost reductions have been implemented in the near term.

Also included in Table 7-11 is a range of environmental externality costs which have been evolving for some time on a state-by-state basis. Numerous studies have been completed and the range of values included in Table 7-11 are indicative of the diversity of results. The intent is to capture the full environmental cost of the respective option, at least in the decision process for option selection. As noted previously, a $500/ton Sulfer tax has been included in the O&M costs, consistent with the USCEA Study. This

1 mill kWhr to the reported busbar costs for the PC plant and 0.2 mills/kWhr to the IGCC plant.

It is realized that the levelized generation cost comparison is but one indicator of merit. In today's "least-cost, integrated-resource-planning", environment, many other factors of business risk, system reliability and infrastructure capability come into play. However, the generation cost serves as a convenient indicator for judging the worthiness of development priority among competing alternatives.

TABLE 7-1
MHTGR FRESH FUEL FABRICATION COSTS
($/Element)
(1992$)

Item	Lead Module	Prototype Expansion	Replica Plant	Target Plant
Initial Core(s)	39,400	23,100	23,100	15,700
Reload 1	39,400	23,100	23,100	15,700
Reload 2	39,400	23,100	23,100	15,700
Reload 3	39,400	19,100	15,700	15,700
Reload 4	23,100	15,700	15,700	13,700
Reload 5	23,100	15,700	15,700	13,700
Reload 6	23,100	15,700	13,700	13,600
Reload 7	19,100	13,700	13,700	13,600
Reload 8	15,700	13,700	13,600	13,600
Reload 9	15,700	13,600	13,600	12,900
Reload 10	15,700	13,600	13,600	12,900
Reload 11	13,700	13,600	12,900	12,900
Reload 12	13,700	13,600	12,900	12,900
Reload 13	13,600	12,900	12,900	12,900
Reload 14	13,600	12,900	12,900	12,900
Reload 15	13,600	12,900	12,900	12,900
Reloads 16-end	12,900	12,900	12,900	12,900

TABLE 7-2
30-YEAR LEVELIZED MHTGR FUEL COSTS
(1992$/MMBTU)

Startup Year (Plant)	Fuel	Conversion	Enrichment	Fabrication	Spent Fuel Disposal[1]	Total
2007 (Lead Module)	.204	.031	.471	.923	.112	1.741
2012 (Prototype)	.204	.031	.471	.575	.112	1.393
2013 (Replica)	.204	.031	.471	.559	.112	1.377
2016 (Target)	.204	.031	.471	.437	.112	1.255

(1) The 1 mill/kWhr legislated by the Waste Policy Act is used for spent fuel disposal, which varies on plant net thermal efficiency. The MHTGR-SC cost is $0.112/MMBTU, the MHTGR-GT/IC is $0.131/MMBTU, and the MHTGR-GT/DC is $0.141/MMBTU.

TABLE 7–3
MHTGR O&M COST SUMMARY (92$)
PROTOTYPE SC, GT/DC, GT/IC PLANTS

	Prototype Steam Cycle	Prototype GT Direct	Prototype GT Indirect
Plant Efficiency/Capacity Factors (%)	38.5/78	48.3/78	44.8/78
On–site staff size (number of personnel)	371	328	358
Power Generation Costs (M$/yr)			
On–site staff salary and payroll taxes	18.23	16.20	17.61
Maintenance materials			
Fixed	2.32	1.83	2.21
Variable	0.77	0.61	0.74
Subtotal	3.09	2.44	2.95
Supplies and expenses			
Fixed	2.72	2.28	3.33
Variable Control Rod & Reflector Block	4.80	4.80	4.80
Other Variable	0.47	0.59	0.55
Subtotal	7.99	7.67	8.68
Offsite technical support			
Corporate	0.32	0.32	0.32
COSO	1.90	1.90	1.90
Subtotal	2.22	2.22	2.22
Subtotal, power generation costs			
Fixed	25.49	22.53	25.37
Variable	6.04	6.00	6.09
Subtotal	31.53	28.53	31.46
Administrative and General Costs (M$/yr)			
Pensions and benefits	4.37	3.89	4.22
Nuclear regulatory fees	3.65	3.65	3.65
Liability insurance	0.62	0.62	0.62
Property insurance	3.58	3.58	3.58
Replacement power insurance	0.00	0.00	0.00
Other administrative & general expenses	4.73	4.28	4.72
Subtotal	16.95	16.02	16.79
Total O&M Costs (M$/yr)			
Fixed	42.44	38.55	42.16
Variable	6.04	6.00	6.09
Total Nonfuel O&M Costs, $M/yr	48.48	44.55	48.25
Mills/kWhr	10.24	7.50	8.76

TABLE 7–4
MHTGR O&M COST SUMMARY (92$)
REPLICA SC, GT/DC, GT/IC PLANTS

	Replica Steam Cycle	Replica GT Direct	Replica GT Indirect
Plant Efficiency/Capacity Factors (%)	38.5/81	48.3/81	44.8/81
On–site staff size (number of personnel)	345	277	299
Power Generation Costs (M$/yr)			
On–site staff salary and payroll taxes	16.96	13.64	14.67
Maintenance materials			
Fixed	2.01	1.57	1.54
Variable	0.67	0.52	0.58
Subtotal	2.68	2.09	2.12
Supplies and expenses			
Fixed	2.72	2.28	3.33
Variable Control Rod & Reflector Block	4.80	4.80	4.80
Other Variable	0.49	0.62	0.57
Subtotal	8.01	7.70	8.70
Offsite technical support			
Corporate	0.32	0.32	0.32
COSO	1.90	1.90	1.90
Subtotal	2.22	2.22	2.22
Subtotal, power generation costs			
Fixed	23.91	19.71	21.76
Variable	5.96	5.94	5.95
Subtotal	29.87	25.65	27.71
Administrative and General Costs (M$/yr)			
Pensions and benefits	4.07	3.28	3.53
Nuclear regulatory fees	3.65	3.65	3.65
Liability insurance	0.62	0.62	0.62
Property insurance	3.58	3.58	3.58
Replacement power insurance	0.50	0.50	0.50
Other administrative & general expenses	4.48	3.85	4.16
Subtotal	16.90	15.48	16.04
Total O&M Costs (M$/yr)			
Fixed	40.81	35.19	37.80
Variable	5.96	5.94	5.95
Total Nonfuel O&M Costs, $M/yr	46.77	41.13	43.75
Mills/kWhr	9.51	6.67	7.65

TABLE 7–5
MHTGR O&M COST SUMMARY (92$)
TARGET SC, GT/DC, GT/IC PLANTS

	Target Steam Cycle	Target GT Direct	Target GT Indirect
Plant Efficiency/Capacity Factors (%)	38.5/84	48.3/84	44.8/84
On–site staff size (number of personnel)	305	223	251
Power Generation Costs (M$/yr)			
On–site staff salary and payroll taxes	15.05	10.94	12.49
Maintenance materials			
Fixed	2.01	1.31	1.43
Variable	0.67	0.42	0.47
Subtotal	2.68	1.73	1.90
Supplies and expenses			
Fixed	2.72	2.28	3.33
Variable Control Rod & Reflector Block	4.80	4.80	4.80
Other Variable	0.51	0.64	0.59
Subtotal	8.03	7.72	8.72
Offsite technical support			
Corporate	0.25	0.25	0.25
COSO	1.69	1.69	1.69
Subtotal	1.94	1.94	1.94
Subtotal, power generation costs			
Fixed	21.72	16.47	19.19
Variable	5.98	5.86	5.86
Subtotal	27.70	22.33	25.05
Administrative and General Costs (M$/yr)			
Pensions and benefits	3.60	2.63	3.00
Nuclear regulatory fees	2.25	2.25	2.25
Liability insurance	0.62	0.62	0.62
Property insurance	1.79	1.79	1.79
Replacement power insurance	0.50	0.50	0.50
Other administrative & general expenses	4.16	3.35	3.76
Subtotal	12.92	11.14	11.92
Total O&M Costs (M$/yr)			
Fixed	34.64	27.61	31.11
Variable	5.98	5.86	5.86
Total Nonfuel O&M Costs, $M/yr	40.62	33.47	36.97
Mills/kWhr	7.97	5.23	6.23

TABLE 7–6
MHTGR BUSBAR GENERATING COSTS ('92$)
PROTOTYPE PLANTS – 2012 STARTUP

	STEAM CYCLE	INDIRECT CYCLE	DIRECT CYCLE
REACTOR THERMAL POWER (MWt)	4x450	4x450	4x450
NET EFFICIENCY (%)	38.5%	44.8%	48.3%
NET ELECTRIC RATING (MWe)	693	806	869
CAPACITY FACTOR	78%	78%	78%
TOTAL CAPITAL COST (M$)	2,185	2,651	2,310
UNIT CAPITAL COST ($/kWe)	3,154	3,288	2,658
FIXED CHARGE RATE	9.53%	9.53%	9.53%
LEVELIZED CAPITAL COST (M$/YR)	208	253	220
FIXED O&M COST (M$/YR)	42.4	42.2	38.6
VARIABLE O&M COST (mills/kWh)	0.3	0.2	0.2
CONTROL ROD & REFLECTOR REPLACE (M$/YR)	4.8	4.8	4.8
ANNUAL O&M COST (M$/YR)	48.5	48.3	44.6
FUEL COST ($/MBTU)	1.47	1.49	1.50
LEVEL FUEL CYCLE COST (M$/YR)	61.7	62.4	62.9
DECOMMISSIONING COST (M$)	194	199	199
LEVEL DECOMMISSIONING (M$/YR)	5.2	5.4	5.4
REVENUE REQUIREMENT (M$/YR)	324	369	333
BUSBAR COST (mills/kWh)			
CAPITAL	44.0	45.9	37.1
O & M	10.2	8.8	7.5
FUEL	13.0	11.3	10.6
DECOMM	1.1	1.0	0.9
TOTAL	68.3	67.0	56.1
BUSBAR COST RELATIVE TO TARGET MHTGR–SC	1.36	1.33	1.12

TABLE 7–7
MHTGR BUSBAR GENERATING COSTS ('92$)
REPLICA PLANTS – 2013 STARTUP

	STEAM CYCLE	INDIRECT CYCLE	DIRECT CYCLE
REACTOR THERMAL POWER (MWt)	4x450	4x450	4x450
NET EFFICIENCY (%)	38.5%	44.8%	48.3%
NET ELECTRIC RATING (MWe)	693	806	869
CAPACITY FACTOR	81%	81%	81%
TOTAL CAPITAL COST (M$)	1,759	2,144	1,812
UNIT CAPITAL COST ($/kWe)	2,539	2,659	2,086
FIXED CHARGE RATE	9.47%	9.47%	9.47%
LEVELIZED CAPITAL COST (M$/YR)	167	203	172
FIXED O&M COST (M$/YR)	40.8	37.8	35.2
VARIABLE O&M COST (mills/kWh)	0.2	0.2	0.2
CONTROL ROD & REFLECTOR REPLACE (M$/YR)	4.8	4.8	4.8
ANNUAL O&M COST (M$/YR)	46.8	43.7	41.1
FUEL COST ($/MBTU)	1.37	1.39	1.40
LEVEL FUEL CYCLE COST (M$/YR)	59.8	60.6	61.0
DECOMMISSIONING COST (M$)	194	199	199
LEVEL DECOMMISSIONING (M$/YR)	5.2	5.4	5.4
REVENUE REQUIREMENT (M$/YR)	278	313	279
BUSBAR COST (mills/kWh)			
CAPITAL	33.9	35.5	27.9
O & M	9.5	7.6	6.7
FUEL	12.2	10.6	9.9
DECOMM	1.1	0.9	0.9
TOTAL	56.7	54.6	45.4
BUSBAR COST RELATIVE TO TARGET MHTGR–SC	1.13	1.09	0.90

TABLE 7–8
MHTGR BUSBAR GENERATING COSTS ('92$)
TARGET PLANTS – 2016 STARTUP

	STEAM CYCLE	INDIRECT CYCLE	DIRECT CYCLE
REACTOR THERMAL POWER (MWt)	4x450	4x450	4x450
NET EFFICIENCY (%)	38.5%	44.8%	48.3%
NET ELECTRIC RATING (MWe)	693	806	869
CAPACITY FACTOR	84%	84%	84%
TOTAL CAPITAL COST (M$)	1,627	1,981	1,659
UNIT CAPITAL COST ($/kWe)	2,349	2,457	1,910
FIXED CHARGE RATE	9.47%	9.47%	9.47%
LEVELIZED CAPITAL COST (M$/YR)	154	188	157
FIXED O&M COST (M$/YR)	34.6	31.1	27.6
VARIABLE O&M COST (mills/kWh)	0.2	0.2	0.2
CONTROL ROD & REFLECTOR REPLACE (M$/YR)	4.8	4.8	4.8
ANNUAL O&M COST (M$/YR)	40.6	37.0	33.5
FUEL COST ($/MBTU)	1.26	1.27	1.28
LEVEL FUEL CYCLE COST (M$/YR)	56.7	57.6	58.0
DECOMMISSIONING COST (M$)	194	199	199
LEVEL DECOMMISSIONING (M$/YR)	5.2	5.4	5.4
REVENUE REQUIREMENT (M$/YR)	257	288	254
BUSBAR COST (mills/kWh)			
CAPITAL	30.2	31.6	24.6
O & M	8.0	6.2	5.2
FUEL	11.1	9.7	9.1
DECOMM	1.0	0.9	0.8
TOTAL	50.3	48.4	39.7
BUSBAR COST RELATIVE TO TARGET MHTGR–SC	1.00	0.96	0.79

TABLE 7–9
BUSBAR GENERATING COSTS ('92$)
NATURAL GAS – 2016 STARTUP

	CCCT HIGH	CCCT REF	CCCT LOW
THERMAL POWER (MWt)	2X550	2X550	2X550
NET EFFICIENCY (%)	45.4%	45.4%	45.4%
NET ELECTRIC RATING (MWe)	500	500	500
CAPACITY FACTOR	84%	84%	84%
TOTAL CAPITAL COST (M$)	311	282	254
UNIT CAPITAL COST ($/kWe)	622	565	508
FIXED CHARGE RATE	9.71%	9.71%	9.71%
LEVELIZED CAPITAL COST (M$/YR)	30	27	25
FIXED O&M COST (M$/YR)	4.7	4.2	3.8
VARIABLE O&M COST (mills/kWh)	0.7	0.6	0.5
SULPHUR TAX @ $500/TON (mills/kWh)	0.0	0.0	0.0
ANNUAL O&M COST (M$/YR)	7.3	6.5	5.6
FUEL COST ($/MBTU)	2.56	2.33	2.10
ANNUAL FUEL CYCLE COST (M$/YR)	70.8	64.4	57.9
DECOMMISSIONING COST (M$)	0	0	0
LEVEL DECOMMISSIONING (M$/YR)	0.0	0.0	0.0
REVENUE REQUIREMENT (M$/YR)	108	98	88
BUSBAR COST (mills/kWh)			
CAPITAL	8.2	7.5	6.7
O & M	2.0	1.8	1.5
FUEL	65.2	39.3	23.6
DECOMM	0.0	0.0	0.0
TOTAL	75.4	48.6	31.8
BUSBAR COST RELATIVE TO TARGET MHTGR–SC	1.50	0.97	0.63

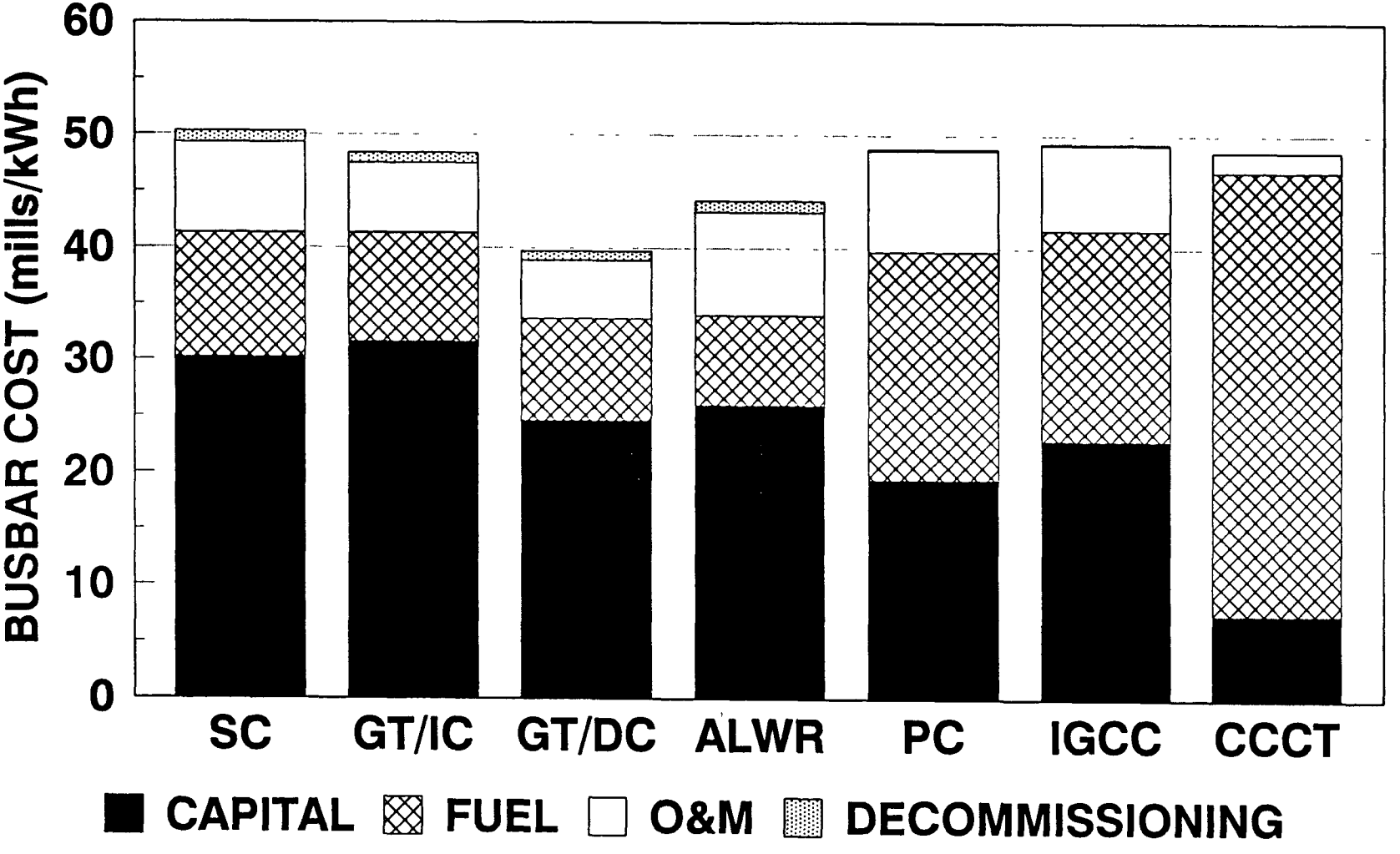
TABLE 7–10
BUSBAR GENERATING COSTS ('92$)
PULVERIZED COAL – 2016 STARTUP

	HIGH	REF	LOW
THERMAL POWER (MWt)	1x1705	1x1705	1x1705
NET EFFICIENCY (%)	35.2%	35.2%	35.2%
NET ELECTRIC RATING (MWe)	600	600	600
CAPACITY FACTOR	80%	80%	80%
TOTAL CAPITAL COST (M$)	920	836	753
UNIT CAPITAL COST ($/kWe)	1,533	1,394	1,255
FIXED CHARGE RATE	9.76%	9.76%	9.76%
LEVELIZED CAPITAL COST (M$/YR)	90	82	74
FIXED O&M COST (M$/YR)	18.8	17.1	15.4
VARIABLE O&M COST (mills/kWh)	4.4	4.0	3.6
SULPHUR TAX @ $500/TON (mills/kWh)	1.0	1.0	0.9
ANNUAL O&M COST (M$/YR)	41.5	37.9	34.3
FUEL COST ($/MBTU)	1.60	1.45	1.31
LEVEL FUEL CYCLE COST (M$/YR)	65.1	59.1	53.2
DECOMMISSIONING COST (M$)	15	15	15
LEVEL DECOMMISSIONING (M$/YR)	0.4	0.4	0.4
REVENUE REQUIREMENT (M$/YR)	197	179	161
BUSBAR COST (mills/kWh)			
CAPITAL	21.4	19.4	17.5
O & M	9.9	9.0	8.2
FUEL	26.8	20.3	15.2
DECOMM	0.1	0.1	0.1
TOTAL	58.2	48.8	41.0
BUSBAR COST RELATIVE TO TARGET MHTGR–SC	1.16	0.97	0.82

TABLE 7–11
SUMMARY GENERATION COST COMPARISON ('92$)
2016 STARTUP, REFERENCE

COST COMPONENTS	MHTGR TARGET PLANTS			ALWR	COAL		GAS
	STEAM CYCLE	GT IC	GT DC	USCEA BASED	PC REF	IGCC REF	CCCT REF
o THERMAL RATING (MWt)	4x450	4x450	4x450	1828	1705	2x655	2x550
o NET RATING (MWe)	693	806	869	600	600	500	500
o NET EFFICIENCY (%)	38.5	44.8	48.3	32.8	35.2	38.1	45.4
o NET HEAT RATE (BTU/kWh)	8,868	7,620	7,070	10,400	9,700	8,950	7,514
o CAPACITY FACTOR (%)	84	84	84	80	80	84	84
o # OF TURBINES	4	4	4	1	1	2	2
o SCHEDULE (OVERALL)	60	63	63	60	42	42	24
o SCHEDULE (CONSTRUCTION)	32	36	36	42	30	30	18
o TOTAL CAPITAL (M$)	1,627	1,981	1,659	1,140	836	862	282
o UNIT CAPITAL ($/kWe)	2,349	2,457	1,910	1,900	1,394	1,723	565
o ANNUAL O&M ($/kWe)	58.6	45.9	38.5	64.2	63.2	55.8	12.9
o FUEL COST ($/MMBTU)	1.26	1.27	1.28	0.77	1.45	1.45	2.33
o REAL ESCALATION (%/YR)	0.0	0.0	0.0	0.0	1.0	1.0	2.2
BUSBAR COST (mills/kWh)							
o CAPITAL	30.2	31.6	24.6	26.0	19.4	22.9	7.5
o O&M	8.0	6.2	5.2	9.2	9.0	7.6	1.8
o FUEL CYCLE	11.1	9.7	9.1	8.0	20.3	18.7	39.3
o DECOMMISSIONING	1.0	0.9	0.8	1.0	0.1	0.1	0.0
TOTAL	50.3	48.4	39.7	44.2	48.8	49.3	48.6
OTHER FACTORS (mills/kWh)							
o ENVIR. EXTER. RANGE	~0–1	~0–1	~0–1	~0–2	~2–40	~1–20	~1–8

FIGURE 7-1
BUSBAR GENERATION COST BREAKDOWN ('92$)
2016 STARTUP, REFERENCE MHTGR TARGET PLANTS



SECTION 8

COST UNCERTAINTY AND MHTGR STRETCH POTENTIAL

8.1 UNCERTAINTY IN FOSSIL FUEL PRICE PROJECTIONS

The relative economic performance of the MHTGR has been compared with coal and natural gas alternatives in Section 7. For plant startup in the year 2016, the MHTGR-SC and MHTGR-GT/IC are projected to be competitive with the pulverized coal (PC), integrated coal gasification combined cycle (IGCC), and the combined cycle combustion turbine (CCCT) alternatives. These options vary by less than 6% in 30 year levelized operating costs. However, the coal and natural gas options are much more dependent on fuel cost assumptions than the MHTGR, with fuel comprising about 40% of the coal estimates and 80% of the natural gas estimates. Conclusions regarding the relative performance must consider the uncertainty in the fossil fuel price projections.

The reference coal and natural gas price projections, published in References 2 and 3, were based on the Energy Information Administration (EIA) Supplement to the Annual Energy Outlook 1992 (Reference 23), Reference Growth Case for delivered fuel cost to electric utilities. Published data through 2010 and unpublished data (Reference 24) from the EIA's AE092 price expectation model through 2040 were used as a model. These data indicated an average real escalation rate to be 1.02% for coal and 2.22% for natural gas between 1990 and 2040. The data referenced were based on the U.S. average conditions and these prices vary significantly by region. The projected U.S regional price for natural gas in 2010 varied from $5.12 to $6.10/MMBTU with the U.S. average being $5.44/MMBTU. Because the groundrules used an average annual real escalation rate, the reference MHTGR natural gas price in 2010 was $3.45/MMBTU. The projected U.S regional prices for coal in 2010 varied from $1.09 to $2.43/MMBTU with the U.S. average being $2.00/MMBTU. The reference MHTGR coal price in 2010 was $1.73. Thus the reference MHTGR fossil fuel prices in 2010 understated the 1992 EIA U.S. average projections by 13.5% for coal and 36.5% for natural gas.

The groundrules for coal and natural gas prices were a conservative basis for evaluating MHTGR economic performance relative to fossil alternatives between 2010 and 2040. This conservatism was introduced because the EIA projections identified higher real escalation rates between 1990 and 2010 than from 2010 to 2040 and the groundrules used an average escalation rate which understates the price over the entire evaluation period. The wide range of current natural gas price projections and the substantial variation in natural gas projections over the past decade indicate a high degree of uncertainty in forecasting these prices. The forecasted coal prices vary to a lesser degree and have been more stable historically.

Figure 8-1 plots the MHTGR groundrule projections (DOE/GCRA) for natural gas against the EIA Annual Energy Outlook 1992 (EIA '92) and several other published projections. The 1993 EIA Annual Energy Outlook (EIA '93), Reference 25, projected lower natural gas escalation rates through 2010 and higher rates after 2040 relative (Reference 26) to EIA '92 and results in the highest projected natural gas price in 2040. Other data points plotted include the U.S. Council of Energy Awareness (USCEA '92)

Study (Reference 9), draft material from the California Energy Commission 1993 Fuels Report (CEC '93, Reference 27), draft material from the 1993 update of the EPRI Technical Assessment Guide (EPRI '93, Reference 28), Gas Research Institute (GRI '93, Reference 29) and the American Gas Association (AGA '92, Reference 30). By the year 2010 these reference case projections vary from the DOE/GCRA reference case of $3.45 to a high of $5.44/MMBTU for the EIA '92, which is nearly 58% higher. In 2040, the projections range from the DOE/GCRA groundrule of $6.62 to $12.69/MMBTU for the EIA '93, which is nearly 92% higher.

Figure 8-2 plots the MHTGR groundrule projections for coal against the EIA '92 and several other published projections. The EIA '93 projected lower coal escalation rates through 2010 and higher rates after 2040 relative to EIA '92 and results in a higher projected coal price in 2040. By the year 2010, these reference case projections vary from the GRI projection of $1.44 to a high of $1.89/MMBTU for the EIA '93, which is nearly 31% higher. The EIA '93 coal price is 9% higher than the DOE/GCRA groundrule projection of $1.73/MMBTU. In 2040, the projections range from the DOE/GCRA groundrule of $2.34 to $2.59/MMBTU for the USCEA '92, which is nearly 11% higher.

Most of the price forecasts have regional price variations and/or alternative economic or resource scenarios that would present even more widely ranging estimates for fossil fuel prices in the future. The DOE/GCRA groundrule conditions for natural gas are very conservative over the period 2010 to 2040 relative to all the other reference projections. The DOE/GCRA groundrule conditions for coal are also conservative relative to EIA and USCEA projections, but are higher than the EPRI and GRI coal price projections. The EPRI coal price projection was based on an East Central site with coal supplied from West Virginia. EPRI reference coal price projections for 2010 vary by region from $0.89 to $1.96/MMBTU with a larger uncertainty band of $0.74 to $2.07/MMBTU.

Figure 8-3 highlights the differences between the MHTGR groundrules reference scenario for natural gas, and the high and low escalation scenarios presented in Table 7-9 and the DOE/EIA Annual Energy Outlook reference scenarios as issued for 1992 and 1993, References 23 and 25. Figure 8-3 highlights the conservativeness of the MHTGR reference scenario relative to EIA 1992 and EIA 1993. In fact, the reference EIA 1993 scenario is nearly identical to the MHTGR high fossil fuel scenario and all seven scenarios evaluated and presented by EIA in the 1993 Annual Energy Outlook forecast natural gas prices higher than the reference MHTGR natural gas scenarios. Figure 8-4 illustrates the impact of the natural gas fuel escalation scenarios as specified in the DOE Advanced Reactor Guidelines, on 30 year levelized busbar generation costs for plant startup rates between 2010 and 2025.

Figure 8-5 shows the competitive advantage of the MHTGR-SC and MHTGR-GT/DC Target Plants relative to the CCCT natural gas plants under the MHTGR groundrules and the larger competitive advantage relative to the EIA '92 reference natural gas forecasts. The reference MHTGR groundrule forecast provides an 11 mills/kWhr advantage relative to the EIA '92 forecast for 2010 startup, closing to 4 mills/kWhr for 2025 startup. This closure reflects the reduction in natural gas escalation rates after 2010 in the EIA '92 natural gas forecast as shown on Figure 8-3.

Figure 8-6 illustrates the competitive advantage of the MHTGR concepts relative to the EIA '93 reference natural gas forecasts. The EIA '93 reference case forecast reflects a 20 mills/Kwhr increase for 2010 startup to more than 50 mills/Kwhr increase for 2025 startup relative to the reference MHTGR scenario. The significant increase in the EIA forecast for natural gas reflects increased consumption of natural gas in the near-term and continued high escalation rates through 2040. The EIA '92 forecast linked natural gas escalation to coal escalation after 2010, apparently due to the expected entry of coal gasification to the gas markets. The EIA '93 forecast removed this linkage to coal.

Under the EIA '93 scenario, coal would be the primary fossil fuel alternative for baseload applications beyond 2010 with a projected busbar cost advantage over natural gas of 30 mills/kWhr. Introduction of clean coal technologies and high efficiency integrated coal gasification combined cycle (IGCC) plants will provide competitive alternatives to the planned MHTGR commercial deployment. Figure 8-7 illustrates the reference MHTGR ground rules for coal escalation, along with the high and low ranges against the EIA '92 and EIA '93 references cases. The MHTGR groundrules are only slightly more conservative than the reference EIA scenarios through 2040. The EIA '93 forecast is actually somewhat less than EIA '92 through 2025 and less than EIA '92 after 2025.

Figure 8-8 shows the 30 year levelized busbar generation costs of pulverized coal plants under the reference MHTGR groundrules and the EIA '93 reference scenario for coal prices delivered to utilities. Pulverized coal is projected to be comparable to the MHTGR-SC Target Plant for 2016 startup under the EIA '93 coal price scenario and maintains a 2 mills/kWhr advantage under the MHTGR groundrules. The MHTGR-GT/DC busbar generation costs are nearly 20% lower than pulverized coal for 2016 startup and the advantage is projected to increase slowly due to the real escalation rate of coal which is assumed to be 1% or more per year.

As in the past, nuclear power will be introduced in regions of the country that generally face higher than U.S. average prices for natural gas and coal, or face other environmental restrictions which limit the fossil alternatives. Clearly the reference coal and natural gas price scenarios specified in the MHTGR groundrules provide a conservative basis for comparison as presented in Section 7.

8.2 UNCERTAINTY IN COST ESTIMATES

The busbar generation costs presented consist of capital costs, operating and maintenance costs, fuel costs, and decommissioning costs. Each cost element is subject to variation, although the busbar cost impact will vary from plant to plant depending on the degree to which the cost element contributes to the total busbar cost. The busbar generation cost sensitivity is presented in Figure 8-9, comparing the three MHTGR concepts with an ALWR, pulverized coal, coal gasification combined cycle, and natural gas combined cycle combustion turbine options.

Table 8-1 provides a summary of the factors changed to estimate the low, target, and high cases presented. The target case is based on the reference MHTGR Target Plant

cost estimates developed in this report and the adjusted USCEA cost estimates originally presented in Table 7-11. For the MHTGR, capital costs ranged from 85% to 115% of the reference capital costs. The 85% factor reflects potential cost reductions that may be obtained through future design optimization or increasing reactor thermal output. Preliminary studies have indicated that the MHTGR-GT has stretch capability, in that core thermal output may be increased from 450 MWt to 500-600 MWt without increasing the reactor vessel. The MHTGR-SC stretch capability is limited relative to the MHTGR-GT by core temperature rise. MHTGR O&M costs were varied from 90% to 110% of the reference O&M costs and MHTGR fuel costs were varied from 90% to 120%. MHTGR decommissioning costs were varied from 75% to 200% reflecting both the current positive decommissioning experience at Fort St. Vrain and the wide range of decommissioning cost estimates that have developed in the last decade. As a result of this range of cost inputs, the MHTGR-GT/DC busbar cost would range from a low of 35 mills/kWhr to a high of 47 mills/kWhr. Identical uncertainty factors were applied to the USCEA based ALWR cost estimate presented in Table 7-11 resulting in ALWR busbar costs ranging from 38 mils/kWhr to 52 mills/kWhr.

The high and low cases developed for the fossil options in Table 8-9 were based on varying capital, O&M, and initial fuel costs by +10% and -10%. The fuel escalation rates were varied from +50% and -50%, reflecting the MHTGR high and low fuel cost projections shown in Figures 8-3 and 8-7 for natural gas and coal, respectively. The combined variation of the initial fuel price and escalation rates resulted in levelized fuel costs varying from 75% to 133% for coal and from 60% to 166% for natural gas. These variations in the cost input result in busbar cost projections for pulverized coal ranging from 41 to 58 mills/kWhr. The IGCC plant ranges from 41 to 58 mills/kWhr. As noted in Section 8.1, the MHTGR reference scenario for natural gas escalation is perceived to be very conservative for natural gas, resulting in an unlikely, low projection of 32 mills/kWhr for the CCCT. The high case for natural gas CCCT increased to 76 mills/kWhr reflecting the high sensitivity of the CCCT to fuel price uncertainty. The high case presented in Figure 8-9 is consistent with the EIA '93 reference case natural gas escalation projections.

The nuclear plant busbar generation costs are dominated by capital costs which comprise nearly 60% of total generation costs. For the MHTGR-SC, capital costs comprise 60.6% of total costs, followed by fuel at 21.7%, O&M at 15.7%, and decommissioning at 2.0%. Due the increased capital costs, higher plant efficiency and reductions in operating staff requirements, the MHTGR-GT/IC generation cost breakdown is 65.7% capital, 19.8% fuel, 12.7% O&M and 1.8% decommissioning. The elimination of the secondary power conversion loop, higher efficiency and further reductions in operating staff permit the MHTGR-GT/DC cost breakdown to change to 62.6% capital, 22.5% fuel, 12.9% O&M, and 2.0% decommissioning. The ALWR cost breakdown, as modified from the Reference 9 USCEA study, is 58.8% capital, 18.1% fuel, 20.8% O&M, and 2.3% decommissioning.

The two coal plant busbar generation costs are more balanced with the capital and fuel components contributing substantially to total generation costs. For the PC the breakdown of generation costs is 39.7% capital, 41.5% fuel, 18.6% O&M, and .2% decommissioning. The more capital intensive, but more efficient IGCC plant is 46.6% capital, 38.1% fuel, 15.1% O&M, and .2% decommissioning. It should be noted that the

IGCC plant unit capital cost is estimated to be only 10% less than the MHTGR-GT/DC Target Plant or the ALWR. With more agreement on future coal price forecasts (less perceived uncertainty) and greater reliance on capital costs, the coal plants projected range of busbar costs is less than that for the natural gas CCCT.

The natural gas CCCT plant is dominated, on the other hand, by fuel which contributes more than 80.4% of the total busbar generation costs. Capital adds 15.3%, O&M adds 4.3%, and decommissioning is assumed to be negligible. The heavy reliance on the fuel cost input and the high level of uncertainty surrounding the future forecasts on natural gas prices leads to the large variation in CCCT total generation costs depicted in Figure 8-9.

Although the CCCT is subject to long-term fuel cost uncertainty, it's low capital cost and short lead time, relative to the other options presented, continue to make it the option of choice in the near-term. Planned improvements in operating efficiency, though partially offset by increased capital costs, may reduce the fuel cost contribution and uncertainty in the future. In addition, the CCCT provides several options to the operator in the event that future natural gas prices increase rapidly. First, the unit may be shifted from baseload to load-following or peaking applications, ideally suited for high fuel cost units. Second, the addition of goal gasification equipment may permit transition of the CCCT plant to IGCC operation when dictated by technology and fuel cost differentials.

In summary, for the near term, the continued expansion of CCCT capacity is a natural response to the low capital and fuel costs. There appears to be a clear consensus, however, that future escalation of natural gas will lead to the use of more capital intensive technologies, including the IGCC, coal and nuclear. As the latter trend evolves, the MHTGR-GT/DC appears to offer significant advantages, both in terms of competitive costs and environmental compatibility.

8.3 MHTGR STRETCH POTENTIAL

The main circulator and steam generator limited MHTGR-SC reactor output to 475 MWt, slightly higher than the reference design output of 450 MWt. However, the evaluation and selection of MHTGR-GT/DC design has reopened consideration of higher reactor power levels. Although the studies have yet to be completed, initial design considerations and cost extrapolations provide an indication of improved plant economics that may be achieved with selection of a higher core thermal output. The study has focused on increasing core thermal output without increasing reactor vessel size by increasing core power density and/or increasing the number of active core columns from 84 to 102. By moving the active annular core region out 1 row, the active core increases by 18 columns and core thermal outputs up to 600 MWt are expected to meet all current licensing and user requirements. Other factors being evaluated include design margins, power conversion vessel size, and commonality with other MHTGR missions, including Plutonium consumption.

The increased plant thermal and electrical output (up to 33%) is offset by relatively small increases in plant capital costs and fuel cycle costs leading to substantial improvements in projected busbar economics. Table 8-2 compares three 600 MWt

reactor modules coupled with three turbomachines with the same electrical output as the reference four module MHTGR-GT/DC plant design. Even though plant facilities and plant staff are shared less effectively, the 3x600 MHTGR-GT/DC plant busbar costs is projected to be nearly 6.6% lower (37.1 vs. 39.7 mills/kWhr). Consideration of larger plant electrical outputs, the busbar generation costs of a 4x600 MHTGR-GT/DC plant are projected to be 34.8 mills/kWhr or 12.3% lower than the reference 4x450 MHTGR-GT/DC power plant as station output increases from 869 MWe to 1,159 MWe. Although the selection of a reference core thermal output will not be made until the trade study is completed, a recommendation to increase the reference core thermal output for the MHTGR-GT/DC plant design is expected.

Further optimization of the MHTGR-GT/DC plant design is expected to take advantage of the fundamental design differences relative to the MHTGR-SC reference design which provided the baseline for the MHTGR-GT plant designs and cost estimates. Together with the ongoing core thermal output trade study, future improvements in MHTGR-GT/DC plant busbar cost estimates are likely.

TABLE 8–1
SUMMARY GENERATION COST COMPARISON ('92$)
COST SENSITIVITY ASSUMPTIONS

	MHTGR TARGET PLANTS			ALWR	COAL		GAS
	STEAM CYCLE	GT IDC	GT DC	USCEA BASED	PC REF	IGCC REF	CCCT REF
LOW CAPITAL	85%	85%	85%	85%	90%	90%	90%
HIGH CAPITAL	115%	115%	115%	115%	110%	110%	110%
LOW O&M	90%	90%	90%	90%	90%	90%	90%
HIGH O&M	110%	110%	110%	110%	110%	110%	110%
LOW FUEL	90%	90%	90%	90%	75%	75%	60%
HIGH FUEL	120%	120%	120%	120%	133%	133%	166%
LOW FUEL ESCALATION	100%	100%	100%	100%	50%	50%	50%
HIGH FUEL ESCALATION	100%	100%	100%	100%	150%	150%	150%
LOW DECOMMISSIONING	75%	75%	75%	75%	100%	100%	100%
HIGH DECOMMISSIONING	200%	200%	200%	200%	100%	100%	100%
LOW FUEL COST IN 1992	$1.13	$1.15	$1.16	$0.69	$1.31	$1.31	$2.10
HIGH FUEL COST IN 1992	$1.38	$1.40	$1.41	$0.85	$1.60	$1.60	$2.56
LOW FUEL ESCALATION RATE	0.00%	0.00%	0.00%	0.00%	0.50%	0.50%	1.10%
HIGH FUEL ESCALATION RATE	0.00%	0.00%	0.00%	0.00%	1.50%	1.50%	3.30%
o TOTAL CAPITAL (M$)	1,627	1,981	1,659	1,140	836	862	282
o UNIT CAPITAL ($/kWe)	2,349	2,457	1,910	1,900	1,394	1,723	565
o ANNUAL O&M ($/kWe)	58.6	45.9	38.5	64.2	63.2	55.8	12.9
o FUEL COST ($/MMBTU)	1.26	1.27	1.28	0.77	1.45	1.45	2.33
o REAL ESCALATION (%/YR)	0.0	0.0	0.0	0.0	1.0	1.0	2.2

TABLE 8–2
SUMMARY GENERATION COST COMPARISON ('92$)
2016 STARTUP, REFERENCE

COST COMPONENTS	MHTGR TARGET PLANTS			ALWR	COAL		GAS
	STEAM CYCLE	GT DC	GT DC	USCEA BASED	PC REF	IGCC REF	CCCT REF
o THERMAL RATING (MWt)	4x450	4x450	3x600	1828	1705	2x655	2x550
o NET RATING (MWe)	693	869	869	600	600	500	500
o NET EFFICIENCY (%)	38.5	48.3	48.3	32.8	35.2	38.1	45.4
o NET HEAT RATE (BTU/kWh)	8,868	7,070	7,070	10,400	9,700	8,950	7,514
o CAPACITY FACTOR (%)	84	84	84	80	80	84	84
o # OF TURBINES	4	4	3	1	1	2	2
o SCHEDULE (OVERALL)	60	63	60	60	42	42	24
o SCHEDULE (CONSTRUCTION)	32	36	33	42	30	30	18
o TOTAL CAPITAL (M$)	1,627	1,659	1,491	1,140	836	862	282
o UNIT CAPITAL ($/kWe)	2,349	1,910	1,716	1,900	1,394	1,723	565
o ANNUAL O&M ($/kWe)	58.6	38.5	36.9	64.2	63.2	55.8	12.9
o FUEL COST ($/MMBTU)	1.26	1.28	1.31	0.77	1.45	1.45	2.33
o REAL ESCALATION (%/YR)	0.0	0.0	0.0	0.0	1.0	1.0	2.2
BUSBAR COST (mills/kWh)							
o CAPITAL	30.2	24.6	22.1	26.0	19.4	22.9	7.5
o O&M	8.0	5.2	5.0	9.2	9.0	7.6	1.8
o FUEL CYCLE	11.1	9.1	9.3	8.0	20.3	18.7	39.3
o DECOMMISSIONING	1.0	0.8	0.7	1.0	0.1	0.1	0.0
TOTAL	50.3	39.7	37.1	44.2	48.8	49.3	48.6
OTHER FACTORS (mills/kWh)							
o ENVIR. EXTER. RANGE	~0–1	~0–1	~0–1	~0–2	~2–40	~1–20	~1–8

TABLE 8–3
SUMMARY GENERATION COST COMPARISON ('92$)
2016 STARTUP, PLANTS OVER 800 MWe

COST COMPONENTS	MHTGR TARGET PLANTS			ALWR		COAL	GAS
	4x450	3x600	4x600	2X600	1X1200	IGCC 4X250	CCCT 4X250
o THERMAL RATING (MWt)	4x450	3x600	4x600	3,657	3,586	4x655	4x550
o NET RATING (MWe)	869	869	1,159	1,200	1,200	1,000	999
o NET EFFICIENCY (%)	48.3	48.3	48.3	32.8	33.5	38.1	45.4
o NET HEAT RATE (BTU/kWh)	7,070	7,070	7,070	10,400	10,200	8,950	7,514
o CAPACITY FACTOR (%)	84	84	84	80	80	84	84
o # OF TURBINES	4	3	4	2	1	4	4
o SCHEDULE (OVERALL)	63	60	63	78	72	42	24
o SCHEDULE (CONSTRUCTION)	36	33	36	60	60	30	18
o TOTAL CAPITAL (M$)	1,658	1,490	1,830	2,034	1,860	1,611	531
o UNIT CAPITAL ($/kWe)	1,910	1,710	1,580	1,695	1,550	1,611	531
o ANNUAL O&M ($/kWe)	38.5	36.9	32.8	54.5	45.5	50.9	11.2
o FUEL COST ($/MMBTU)	1.28	1.31	1.31	0.77	0.77	1.45	2.33
o REAL ESCALATION (%/YR)	0.0	0.0	0.0	0.0	0.0	1.0	2.2
BUSBAR COST (mills/kWh)							
o CAPITAL	24.6	22.1	20.3	23.2	21.2	21.4	7.0
o O&M	5.2	5.0	4.5	7.8	6.5	6.9	1.5
o FUEL CYCLE	9.1	9.3	9.3	8.0	7.9	18.7	39.3
o DECOMMISSIONING	0.8	0.7	0.7	0.6	0.6	0.1	0.0
TOTAL	39.7	37.1	34.8	39.6	36.2	47.1	47.8
OTHER FACTORS (mills/kWh)							
o ENVIR. EXTER. RANGE	~0–1	~0–1	~0–1	~0–2	~0–2	~1–20	~1–8

FIGURE 8-1
FORECASTED NATURAL GAS PRICES TO UTILITIES

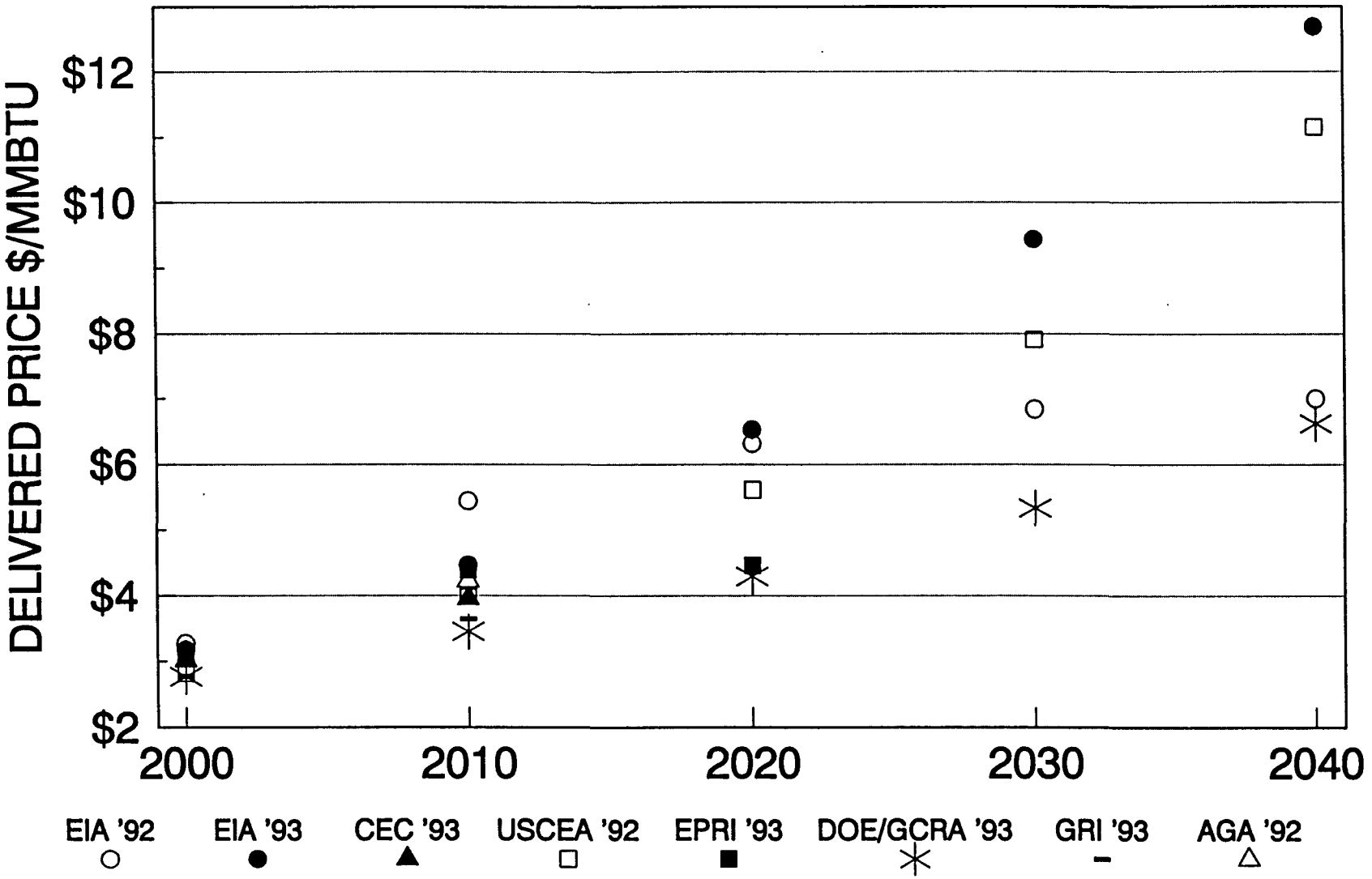


FIGURE 8-2
FORECASTED COAL PRICES DELIVERED TO UTILITIES

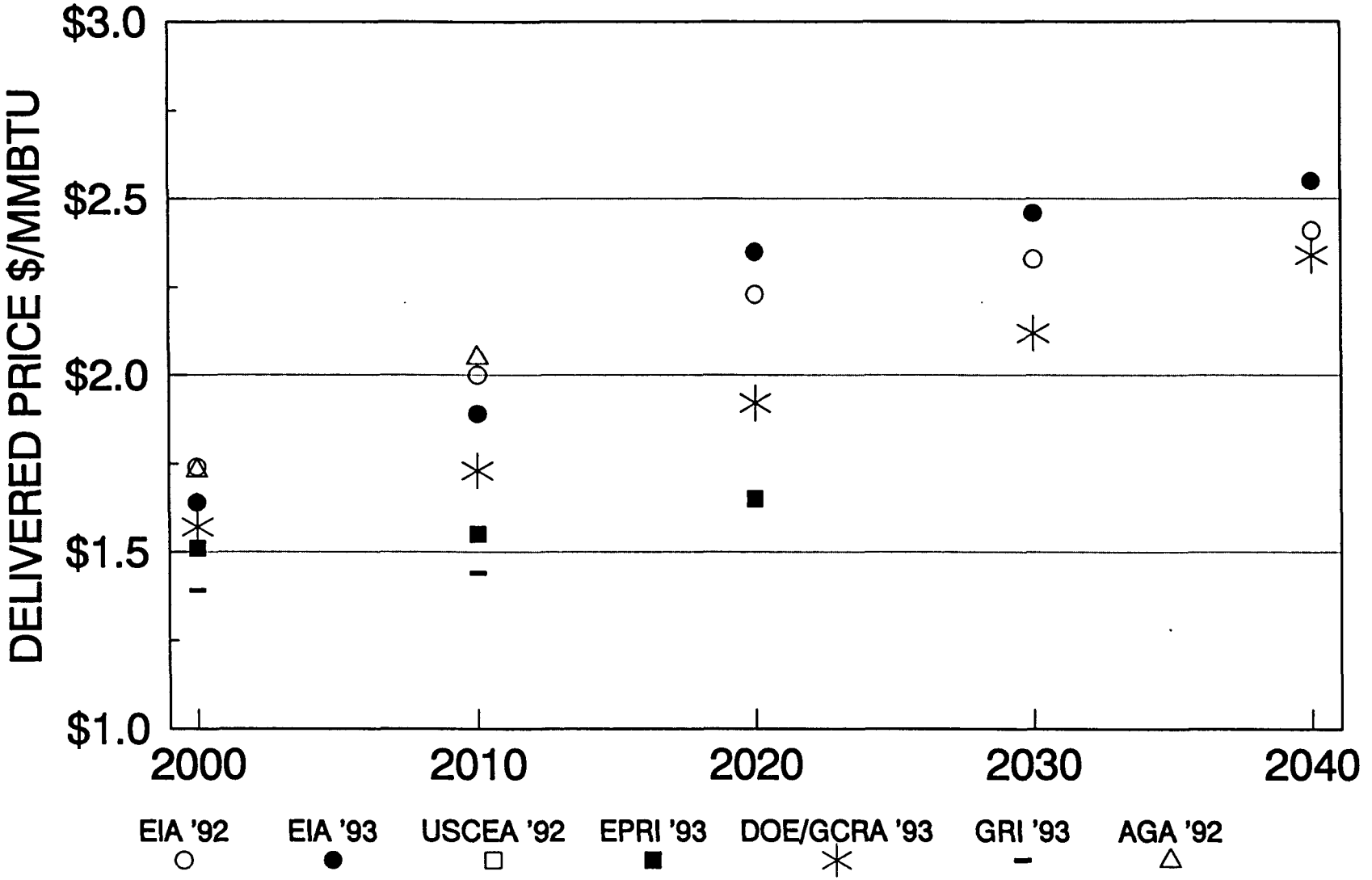


FIGURE 8-3
NATURAL GAS PRICES DELIVERED TO UTILITY (1992$/MMBTU)
GROUNDRULES VS. 1992/1993 EIA ANNUAL ENERGY OUTLOOK

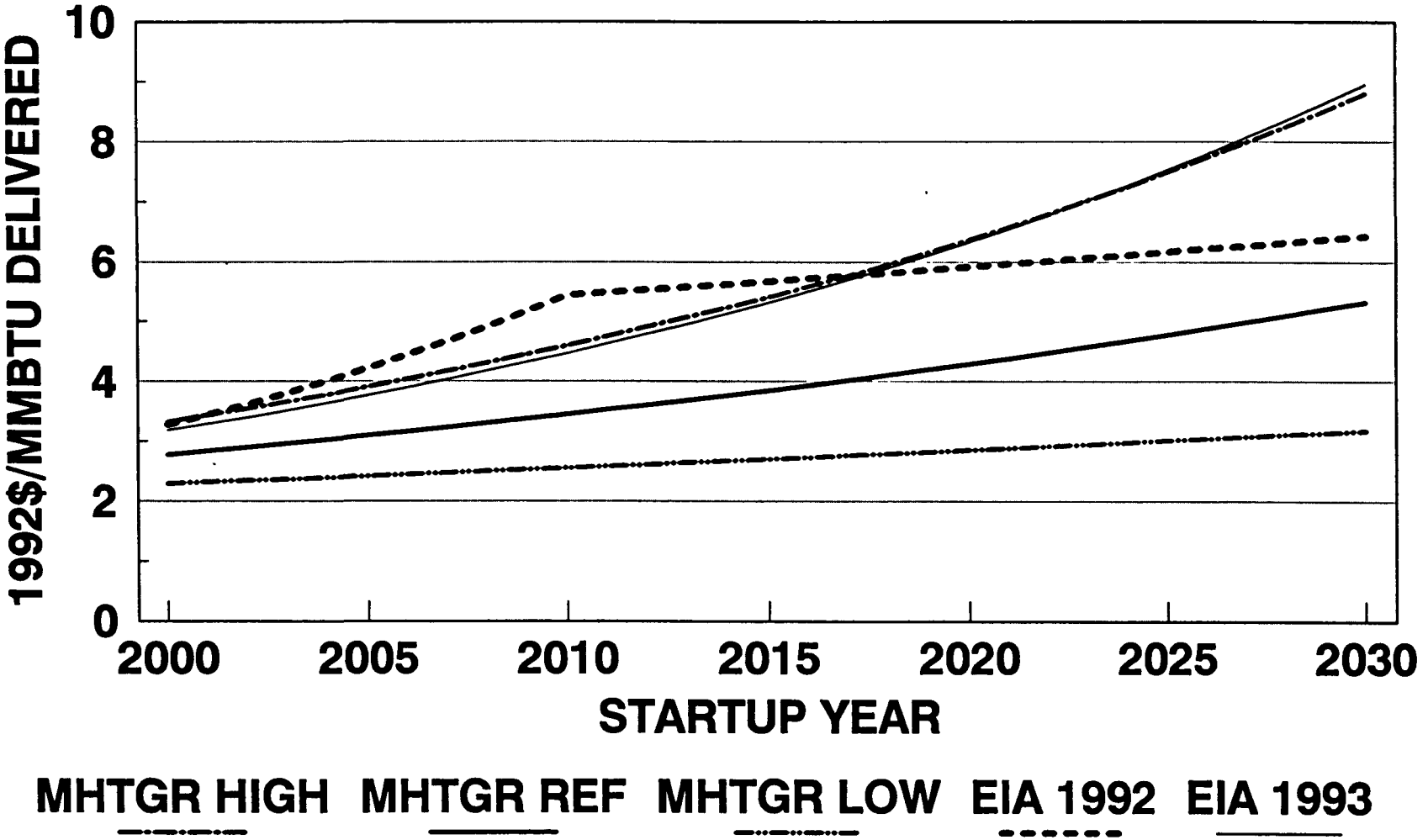
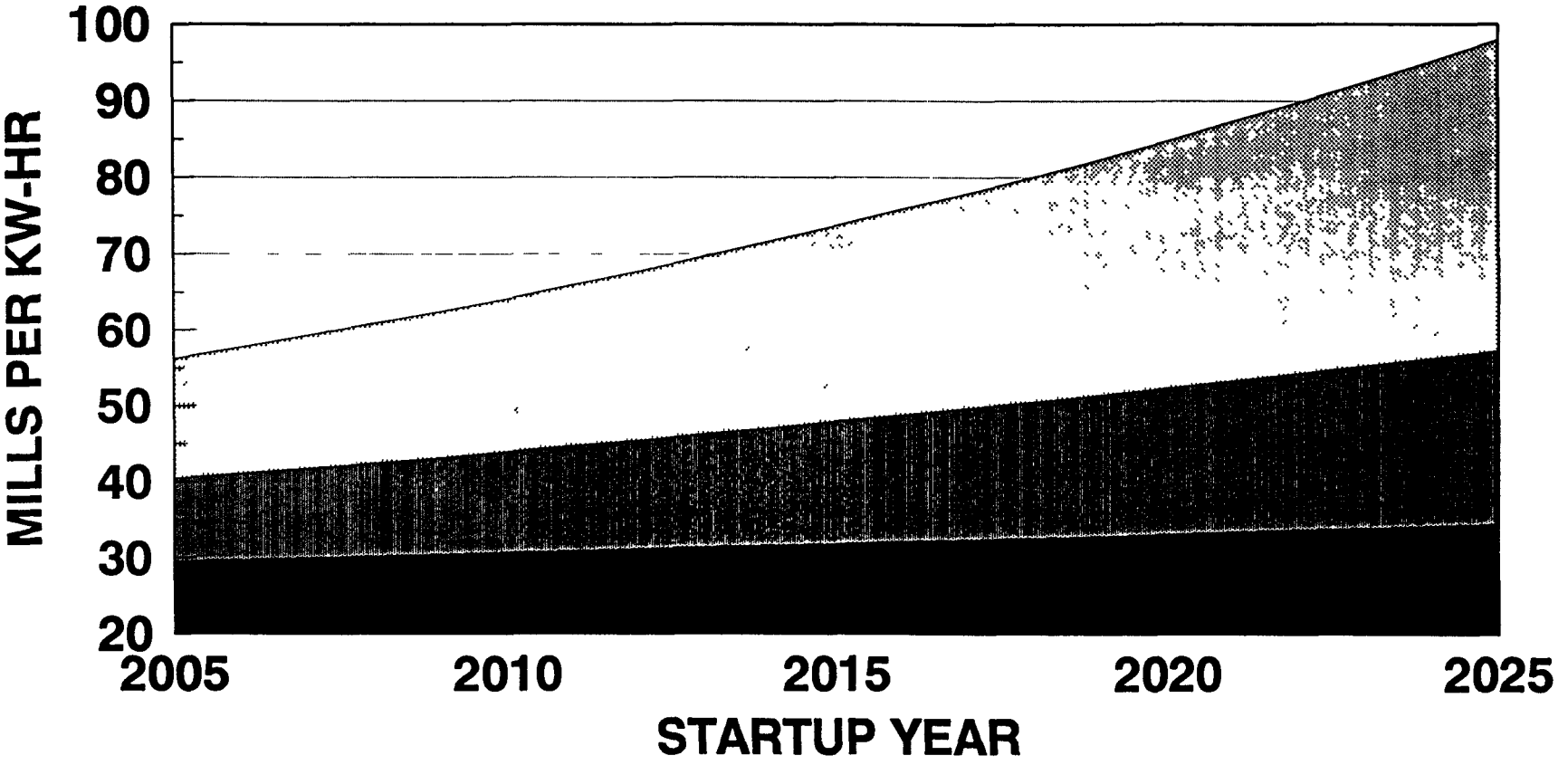
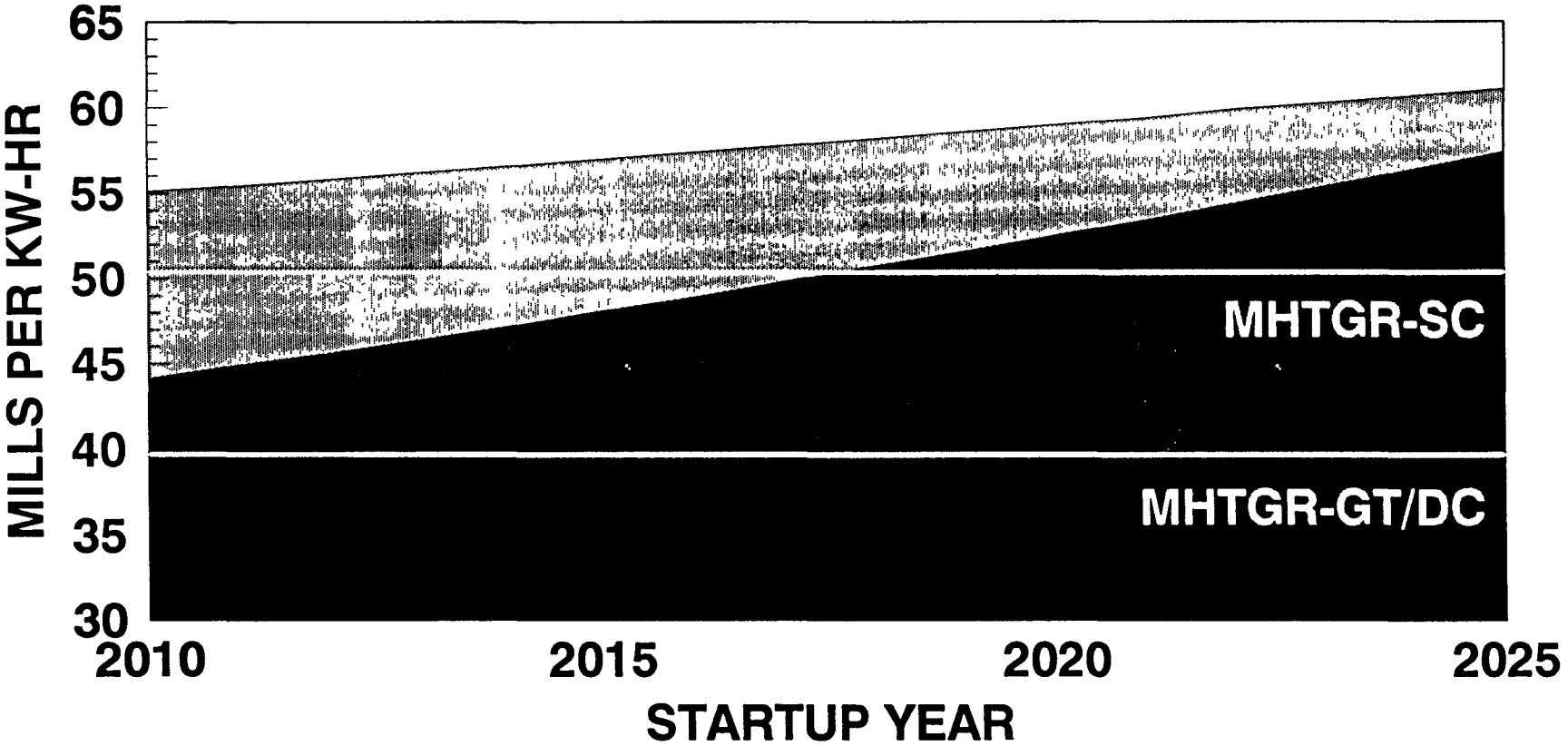


FIGURE 8-4
NATURAL GAS CCCT (2X250 MWe) DOE GROUNDRULES
30 YEAR LEVELIZED POWER GENERATION COSTS



REFERENCE PER DOE/ORNL GUIDELINES

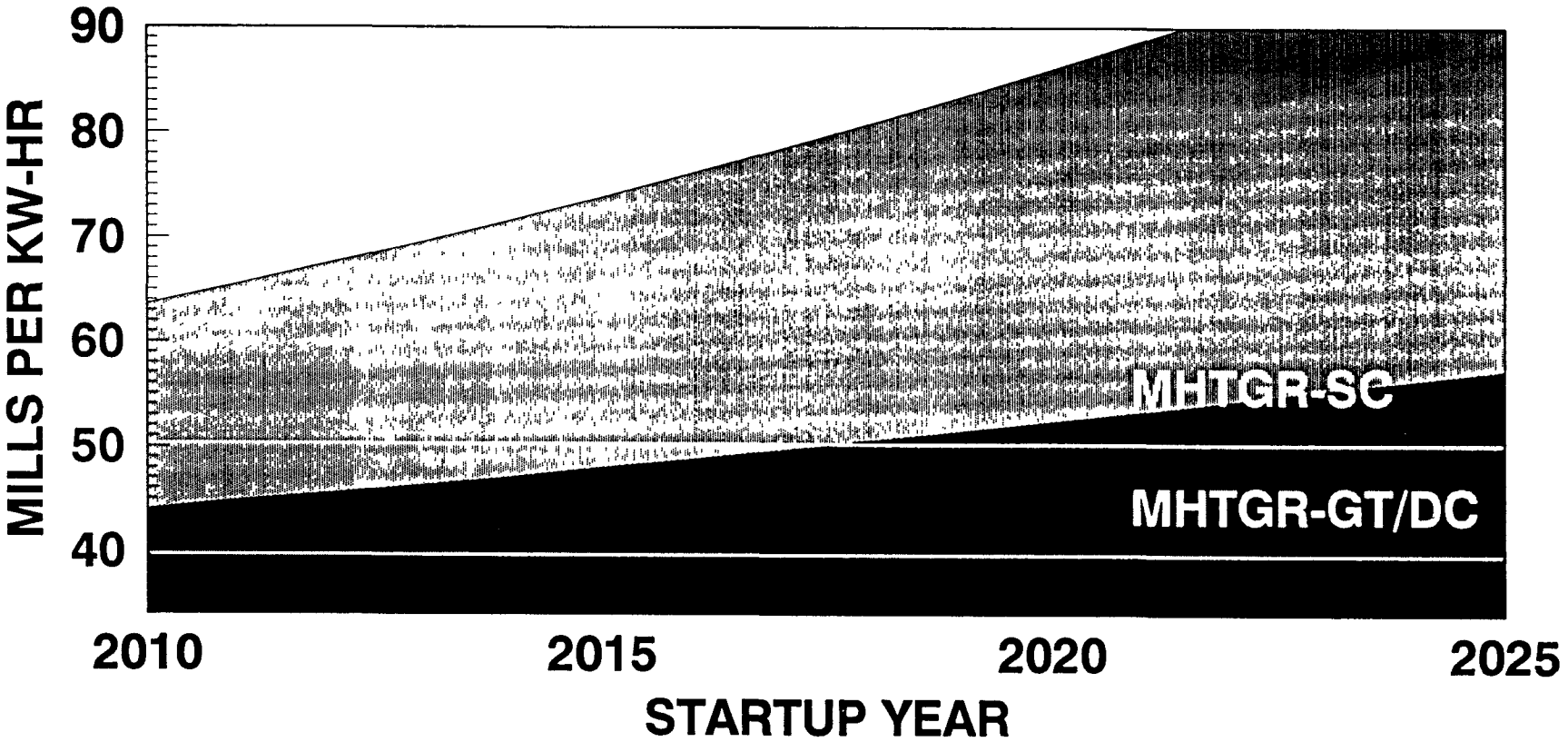
FIGURE 8-5
MHTGR TARGET PLANTS VS. EIA 1992 NATURAL GAS CCCT
30 YEAR LEVELIZED POWER GENERATION COSTS



■ MHTGR GROUNDRULES ■ ANNUAL ENERGY OUTLOOK

ADVANCED REACTOR GROUNDRULES VS. EIA REFERENCE
CASE 1992 ANNUAL ENERGY OUTLOOK

FIGURE 8-6
MHTGR TARGET PLANT VS. EIA 1993 NATURAL GAS CCCT
30 YEAR LEVELIZED POWER GENERATION COSTS



■ MHTGR GROUNDRULES ■ ANNUAL ENERGY OUTLOOK

ADVANCED REACTOR GROUNDRULES VS. EIA REFERENCE
CASE 1993 ANNUAL ENERGY OUTLOOK

FIGURE 8-7
COAL PRICES DELIVERED TO UTILITY (1992$/MMBTU)
GROUNDRULES VS. 1992/1993 EIA ANNUAL ENERGY OUTLOOK

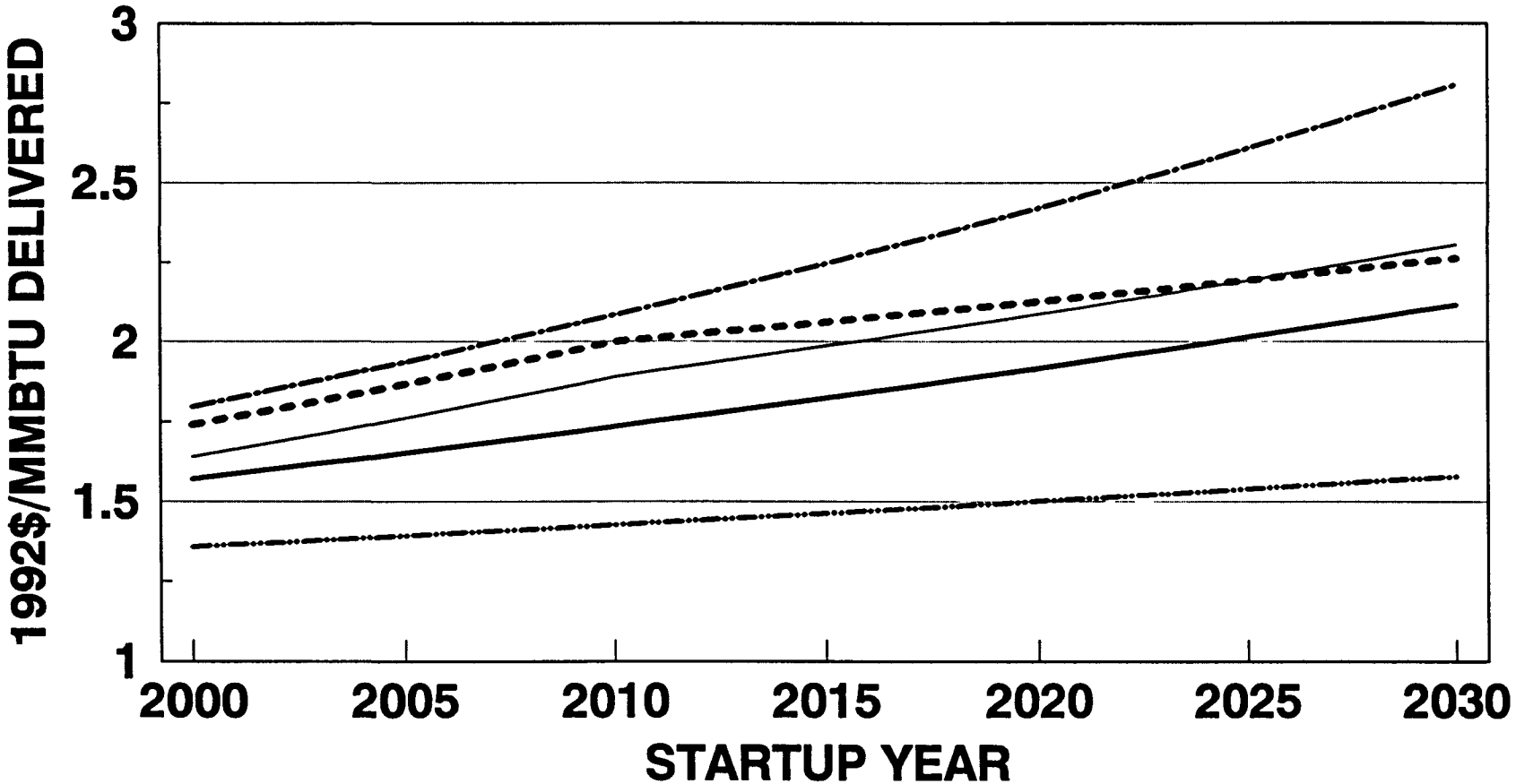
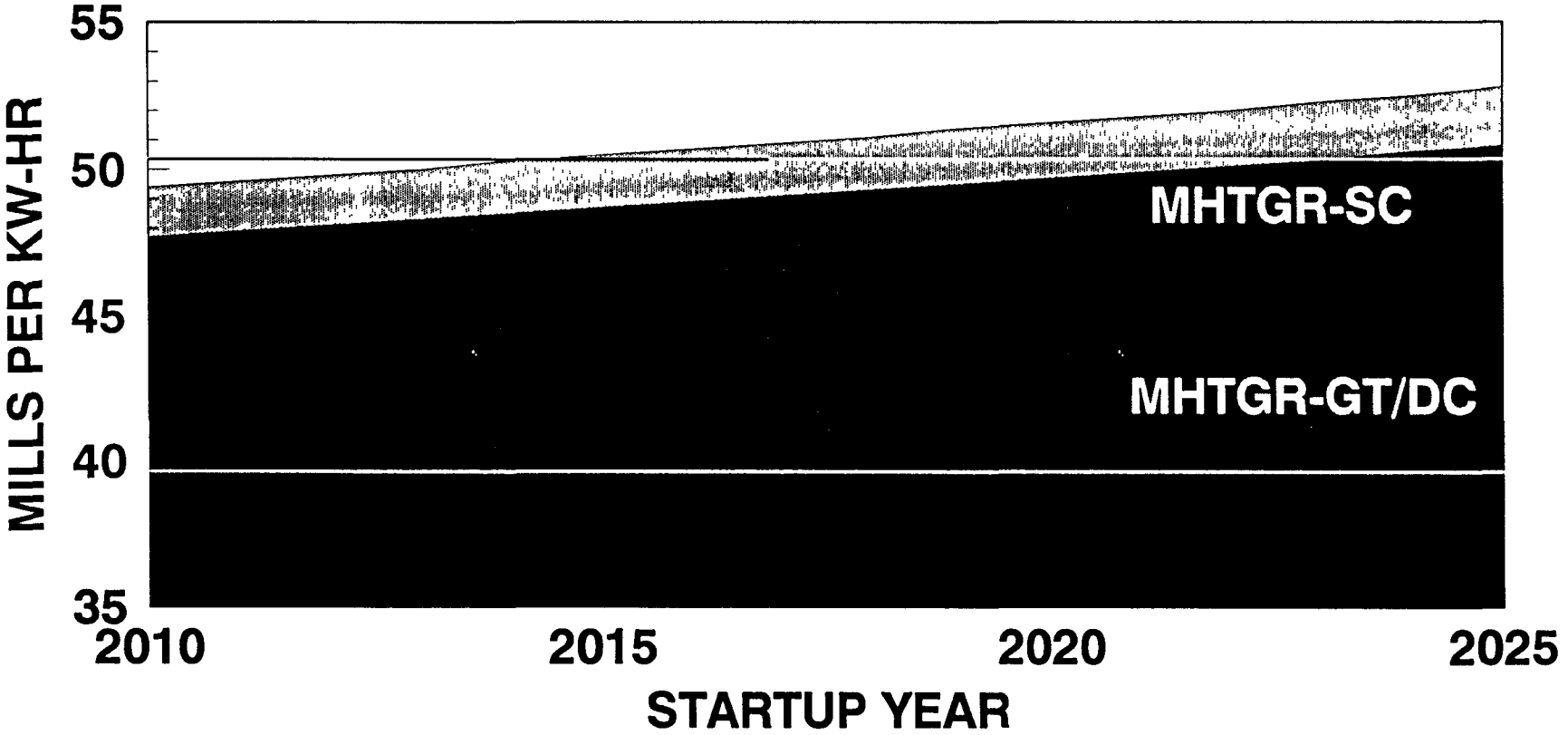


FIGURE 8-8
MHTGR TARGET PLANT VS. EIA 1993 PULVERIZED COAL
30 YEAR LEVELIZED POWER GENERATION COSTS



■ MHTGR GROUNDRULES ■ ANNUAL ENERGY OUTLOOK

ADVANCED REACTOR GROUNDRULES VS. EIA REFERENCE
CASE 1993 ANNUAL ENERGY OUTLOOK

FIGURE 8-9
BUSBAR GENERATION COST SENSITIVITY ('92$)
2016 STARTUP

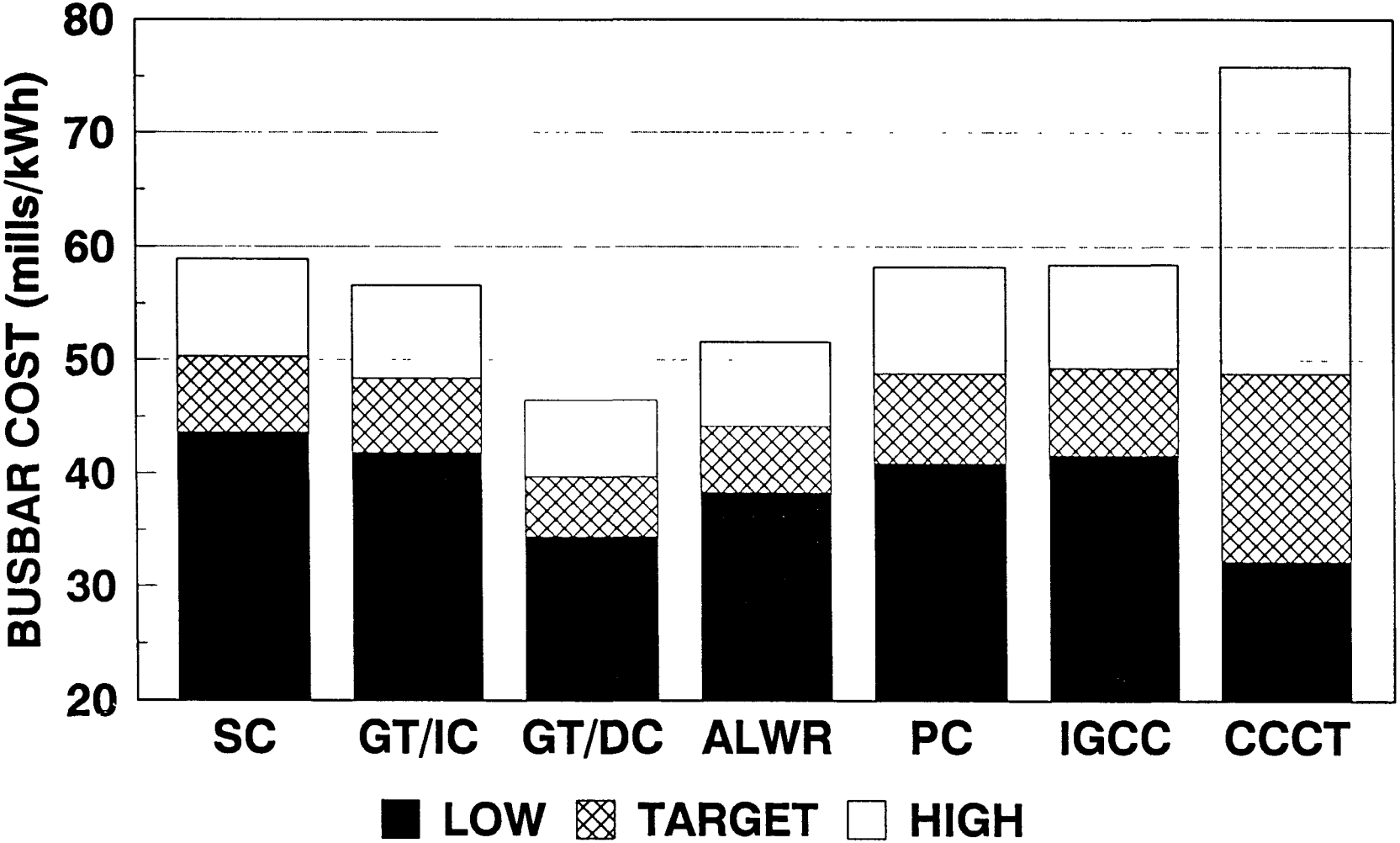
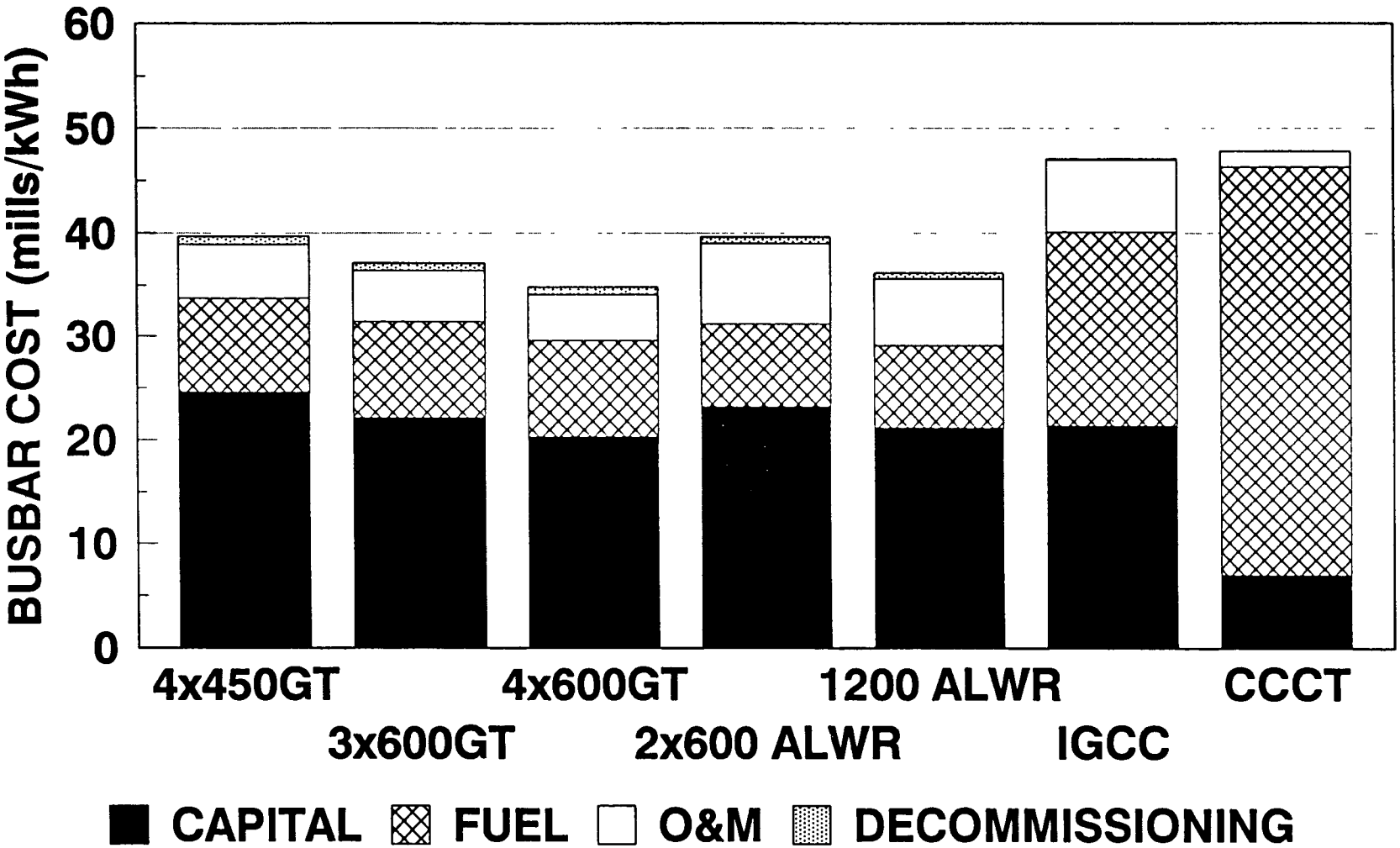


FIGURE 8-10
BUSBAR GENERATION COST BREAKDOWN ('92$)
2016 STARTUP, TARGET PLANTS OVER 800 MWe



SECTION 9

REFERENCES

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APPENDIX A

HTGR WORK BREAKDOWN STRUCTURE

TABLE A-1

HTGR WORK BREAKDOWN STRUCTURE

ACCOUNT	TITLE
1000	******** HTGR TECHNOLOGY *******
1400	INTERNATIONAL TECHNOLOGY TRANSFER
1600	BASE TECHNOLOGY
1601	FUELS & FISSION PRODUCT BEHAVIOR
1602	GRAPHITE BASE TECHNOLOGY
1603	METALS BASE TECHNOLOGY
1604	SAFETY TECHNOLOGY
1605	TECHNOLOGY SUPPORT
1606	SHIELDING TECHNOLOGY
1607	CERAMICS BASE TECHNOLOGY
1700	SUPPORTING TECHNOLOGY
1711	REACTOR SYSTEM DESIGN SUPPORT
1712	VESSEL SYSTEM DESIGN SUPPORT
1713	HEAT TRANSPORT SYSTEM DESIGN SUPPORT
1714	SHUTDOWN COOLING SYSTEM DESIGN SUPPORT
1716	REACTOR CAVITY COOLING SYSTEM DESIGN SUPPORT
1721	FUEL HANDLING & STORAGE SYSTEM DESIGN SUPPORT
1731	REACTOR PROTECTION SYSTEM DESIGN SUPPORT
1734	CONTR, DATA & INSTRUMENTATION SYSTEM DESIGN SUPPORT
1735	PLANT MONITORING SYSTEM DESIGN SUPPORT
1900	TECHNOLOGY PROGRAM MANAGEMENT
5000	********** MHTGR DESIGN **********
5100	MHTGR PLANT-LEVEL DESIGN & ANALYSIS
5100	PLANT-LEVEL DESIGN & ANALYSIS - GENERAL
5101	PLANT-LEVEL DESIGN & INTEGRATION
5102	PLANT LEVEL ANALYSIS
5103	AVAILABILITY/RELIABILITY ASSESSMENTS
5104	OPERATIONS, MAINTENANCE & ISI
5105	FABRICATION/CONSTRUCTION
5106	CONTROL OF RADIONUCLIDE RELEASE

TABLE A-1
(Continued)
HTGR WORK BREAKDOWN STRUCTURE

ACCOUNT	TITLE
5200	SYSTEMS LEVEL DESIGN
5211	REACTOR SYSTEM
5212	VESSEL SYSTEM
5213	HEAT TRANSPORT SYSTEM
5214	SHUTDOWN COOLING SYSTEM
5215	SHUTDOWN COOLING WATER SYSTEM
5216	REACTOR CAVITY COOLING SYSTEM
5221	FUEL HANDLING & STORAGE SYSTEM
5222	SPENT FUEL COOLING SYSTEM
5223	NUCLEAR ISLAND COOLING WATER SYSTEM
5224	HELIUM SERVICES SYSTEM
5225	RADWASTE & DECONTAMINATION SYSTEM
5231	REACTOR PROTECTION SYSTEM
5232	STEAM & WATER DUMP SYSTEM
5233	INVESTMENT PROTECTION SYSTEM
5234	PLANT CONTROL, DATA & INSTRUMENTATION SYSTEM
5235	PLANT MONITORING SYSTEM
5241	TURBINE GENERATOR & AUXILIARIES
5242	MAIN & AUXILIARY STEAM
5243	FEEDWATER AND CONDENSATE
5244	STARTUP & SHUTDOWN SYSTEM
5251	REACTOR COMPLEX DESIGN
5252	HELIUM SERVICE BUILDING
5253	HELIUM STORAGE STRUCTURE
5254	REMOTE SHUTDOWN BUILDING
5255	NUCLEAR ISLAND WAREHOUSE
5261	OPERATIONS CENTER DESIGN
5262	TURBINE COMPLEX DESIGN
5263	CIRCULATING WATER HOUSE
5264	MAKEUP WATER & DISCHARGE STRUCTURE
5265	FIRE PUMP HOUSE
5266	ENERGY CONVERSION AREA WAREHOUSE
5267	MISCELLANEOUS SITE IMPROVEMENTS
5271	ENERGY CONVERSION AREA COOLING WATER SYSTEM
5272	CIRCULATING WATER SYSTEM
5273	WATER SUPPLY & TREATMENT SYSTEM
5274	PLANT HOT WATER HEATING SYSTEM
5275	PLANT CHILLED WATER SYSTEM
5276	PLANT FIRE PROTECTION SYSTEM

TABLE A-1
(Continued)
HTGR WORK BREAKDOWN STRUCTURE

ACCOUNT	TITLE
5281	NUCLEAR ISLAND HVAC SYSTEM
5282	ENERGY CONVERSION AREA HVAC SYSTEM
5283	INSTRUMENT & SERVICE AIR SYSTEM
5284	WASTE WATER SYSTEM
5285	YARD DRAINAGE SYSTEM
5286	SANITARY DRAINAGE & TREATMENT SYSTEM
5291	ESSENTIAL AC ELECTRICAL SYSTEM
5292	PLANT AC ELECTRICAL SYSTEM
5293	GROUNDING, LIGHTING, HEAT TRACING & CATHODIC PROTECTION SYSTEM
5294	ESSENTIAL DC ELECTRICAL SYSTEM
5295	PLANT DC ELECTRICAL SYSTEM
5296	COMMUNICATION SYSTEM DESIGN
5297	PLANT SECURITY SYSTEM
5900	DESIGN MANAGEMENT & COST DEVELOPMENT
9000	******DESIGN PROGRAM SUPPORT******
9100	PROGRAM DEVELOPMENT, PLANNING & CONTROL
9200	UTILITY/USER REQUIREMENTS & DESIGN EVALUATION
9300	LICENSING
9400	QUALITY ASSURANCE
9900	PLANT DESIGN CONTROL OFFICE

APPENDIX B

EEDB CODE OF ACCOUNTS

TABLE B-1

EEDB CODE OF ACCOUNTS
FOR THE MHTGR PLANT
CAPITAL COSTS

2 DIRECT COSTS

20 LAND AND LAND RIGHTS

200 - LAND AND LAND RIGHTS

21 STRUCTURES AND IMPROVEMENTS
211 - YARD WORK
212 - REACTOR COMPLEX
213 - TURBINE COMPLEX
214 - OPERATIONS CENTER
215 - REMOTE SHUTDOWN BUILDING
216 - OTHER BUILDINGS

22 REACTOR PLANT EQUIPMENT

221 - REACTOR SYSTEM
222 - VESSEL SYSTEM
223 - HEAT TRANSPORT SYSTEM
224 - SHUTDOWN COOLING SYSTEM
225 - SHUTDOWN COOLING WATER SYSTEM
226 - REACTOR CAVITY COOLING SYSTEM
227 - REACTOR SERVICE SYSTEMS
228 - PLANT CONTROL, PROTECTION AND MONITORING SYSTEMS
229 - REACTOR PLANT MISCELLANEOUS ITEMS

23 TURBINE PLANT EQUIPMENT

231 - TURBINE GENERATOR & AUXILIARIES SYSTEM
233 - MAIN & AUXILIARY STEAM SYSTEM
234 - FEEDWATER & CONDENSATE SYSTEM
235 - STARTUP & SHUTDOWN SYSTEM
236 - TURBINE PLANT SAMPLING
237 - ECA CONTROL, DATA AND INSTRUMENTATION SYSTEMS

TABLE B-1
(Continued)
EEDB CODE OF ACCOUNTS
FOR THE MHTGR PLANT
CAPITAL COSTS

24 ELECTRIC PLANT EQUIPMENT

- 241 - SWITCHGEAR
- 242 - STATION SERVICE EQUIPMENT
- 243 - SWITCHBOARDS
- 244 - PROTECTIVE EQUIPMENT
- 245 - ELECTRICAL STRUCTURES AND WIRING CONTAINERS
- 246 - POWER AND CONTROL WIRING

25 MISCELLANEOUS PLANT EQUIPMENT

- 251 - TRANSPORTATION AND LIFT EQUIPMENT
- 252 - AIR, WATER, AND STEAM SERVICE SYSTEMS
- 253 - COMMUNICATIONS AND SECURITY EQUIPMENT
- 254 - FURNISHINGS AND FIXTURES

26 HEAT REJECTION SYSTEM

- 261 - CIRCULATING & SERVICE WATER PUMP HOUSE
- 262 - ECA COOLING WATER SYSTEM
- 263 - CIRCULATING & SERVICE WATER SYSTEM

9 INDIRECT COSTS

91 CONSTRUCTION SERVICES

- 911 - TEMPORARY CONSTRUCTION FACILITIES
- 912 - CONSTRUCTION TOOLS AND EQUIPMENT
- 913 - PAYROLL INSURANCE AND TAXES
- 914 - PERMITS, INSURANCE AND LOCAL TAXES

TABLE B-1
(Continued)
EEDB CODE OF ACCOUNTS
FOR THE MHTGR PLANT
CAPITAL COSTS

92 HOME OFFICE ENGINEERING AND SERVICES

- 920 - REACTOR MODULE ENGINEERING & SERVICES
- 921 - PLANT ENGINEERING & SERVICES
- 922 - HOME OFFICE QUALITY ASSURANCE
- 923 - HOME OFFICE PROJECT & CONSTRUCTION MANAGEMENT

93 FIELD OFFICE AND SERVICES

- 931 - FIELD OFFICE EXPENSES
- 932 - FIELD JOB SUPERVISION
- 933 - FIELD OFFICE QUALITY ASSURANCE/QUALITY CONTROL
- 934 - TEST AND START-UP ENGINEERING

94 OWNER'S COST

- 941 - PROJECT MANAGEMENT EXPENSES
- 942 - FEES, TAXES, AND INSURANCE
- 943 - SPARE PARTS, AND CAPITAL EQUIPMENT
- 944 - STAFF TRAINING AND START-UP
- 945 - G & A

APPENDIX C

THREE DIGIT LEVEL CAPITAL COST SUMMARIES

APPENDIX C

THREE DIGIT LEVEL CAPITAL COST SUMMARIES

TABLE C–1
MHTGR–SC LEAD MODULE BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
211	YARDWORK	0	107,620	2,507,546	1,365,975	3,873,521	756,000	81,462	1,994,479	669,886	3,420,365	7,293,886
212	REACTOR COMPLEX	3,755,500	1,081,969	26,353,179	19,827,669	49,936,348	0	0	0	0	0	49,936,348
213	TURBINE COMPLEX	0	0	0	0	0	1,376,866	155,502	3,963,201	3,758,671	9,118,937	9,118,937
214	OPERATIONS CENTER	0	0	0	0	0	2,145,000	71,503	1,857,579	445,890	4,448,469	4,448,469
215	REMOTE SHUTDOWN BUILDING	0	3,622	89,873	60,097	149,970	0	0	0	0	0	149,970
216	OTHER BUILDINGS	0	26,628	693,295	881,154	1,574,449	520,500	41,808	1,011,411	324,610	1,856,521	3,430,970
21	STRUCTURES & IMPROVEMENTS	3,755,500	1,219,839	29,643,893	22,134,895	55,534,288	4,798,366	350,275	8,846,670	5,199,257	18,844,292	74,378,580
221	REACTOR SYSTEM	52,048,000	22,988	567,221	0	52,615,221	0	0	0	0	0	52,615,221
222	VESSEL SYSTEM	37,739,750	47,456	1,163,146	53,430	38,956,326	0	0	0	0	0	38,956,326
223	HEAT TRANSPORT SYSTEM	36,957,000	7,402	194,511	2,350	37,153,861	0	0	0	0	0	37,153,861
224	SHUTDOWN COOLING SYSTEM	5,601,000	9,132	234,057	10,720	5,845,777	0	0	0	0	0	5,845,777
225	SHUTDOWN COOLING WATER SYSTEM	740,000	8,447	210,977	216,800	1,167,777	0	0	0	0	0	1,167,777
226	REACTOR CAVITY COOLING SYSTEM	3,200,000	31,049	827,481	925,200	4,952,681	0	0	0	0	0	4,952,681
227	REACTOR SERVICE SYSTEM	37,116,400	143,684	3,588,031	1,061,934	41,766,365	653,900	8,172	203,763	176,919	1,034,582	42,800,947
228	REACTOR CONTROL, PROTECTION & MONITORING	3,485,900	46,797	1,242,617	1,065,000	5,793,517	187,000	3,735	91,545	0	278,545	6,072,062
229	REACTOR PLANT MISCELLANEOUS	11,592,000	10,000	245,100	500,000	12,337,100	0	0	0	0	0	12,337,100
22	REACTOR PLANT EQUIPMENT	188,480,050	326,955	8,273,141	3,835,434	200,588,625	840,900	11,907	295,308	176,919	1,313,127	201,901,752
231	TURBINE GENERATOR & AUXILIARIES	0	0	0	0	0	24,238,500	103,280	2,520,859	457,672	27,217,031	27,217,031
233	MAIN & AUXILIARY STEAM SYSTEM	0	0	0	0	0	2,126,807	49,464	1,236,329	661,877	4,025,013	4,025,013
234	FEEDWATER & CONDENSATE SYSTEM	0	0	0	0	0	6,543,720	118,867	2,937,402	718,780	10,199,902	10,199,902
235	STARTUP & SHUTDOWN SYSTEM	0	0	0	0	0	0	0	0	0	0	0
236	TURBINE PLANT SAMPLING SYSTEM	0	0	0	0	0	549,000	5,600	137,256	0	686,256	686,256
237	ECA CONTROL, DATA & INSTRUMENTATION	0	5,480	145,822	44,000	189,822	5,715,000	35,700	949,977	0	6,664,977	6,854,799
23	TURBINE PLANT EQUIPMENT	0	5,480	145,822	44,000	189,822	39,173,027	312,911	7,781,823	1,838,329	48,793,179	48,983,001
241	SWITCHGEAR	0	3,950	106,453	0	106,453	1,741,820	6,930	186,765	0	1,928,585	2,035,038
242	STATION SERVICE EQUIPMENT	1,527,150	11,229	302,621	6,136	1,835,907	2,970,580	13,528	356,020	47,580	3,374,180	5,210,087
243	SWITCHBOARDS	0	240	6,468	0	6,468	997,400	1,010	27,220	0	1,024,620	1,031,088
244	PROTECTIVE EQUIPMENT	0	0	0	0	0	101,200	10,833	291,951	55,000	448,151	448,151
245	ELECTRIC STRUCTURES & WIRING CONTAINERS	0	129,040	3,477,629	0	3,477,629	0	14,370	387,272	247,580	634,852	4,112,481
246	POWER AND CONTROL WIRING	0	82,941	2,235,260	0	2,235,260	0	24,032	647,665	1,065,948	1,733,613	3,968,873
24	ELECTRIC PLANT EQUIPMENT	1,527,150	227,400	6,128,431	6,136	7,661,717	5,811,000	70,703	1,896,893	1,436,108	9,144,001	16,805,718

TABLE C–1
MHTGR–SC LEAD MODULE BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
251	TRANSPORTATION AND LIFT EQUIPMENT	922,500	7,180	175,982	9,000	1,107,482	652,200	3,856	94,511	10,738	757,449	1,864,931
252	AIR, WATER, AND STEAM SERVICE SYSTEM	809,000	271,552	6,785,948	985,021	8,579,969	7,836,300	311,453	7,634,040	3,418,792	18,889,132	27,469,101
253	COMMUNICATIONS AND SECURITY EQUIPMENT	0	11,014	293,083	2,102,440	2,395,523	962,000	37,191	1,002,298	0	1,964,298	4,359,821
254	FURNISHINGS AND FIXTURES	198,000	1,968	52,505	1,112,850	1,363,355	458,750	3,501	85,810	0	544,560	1,907,915
25	MISCELLANEOUS PLANT EQUIPMENT	1,929,500	291,714	7,307,518	4,209,311	13,446,329	9,909,250	356,001	8,816,659	3,429,530	22,155,439	35,601,768
261	CIRCULATING AND SERVICE WATER PUMPHOUSE	0	0	0	0	0	1,800	7,196	173,474	99,384	274,658	274,658
262	ECA COOLING WATER SYSTEMS	0	0	0	0	0	320,400	18,790	473,190	199,525	993,115	993,115
263	CIRCULATING AND SERVICE WATER SYSTEM	0	0	0	0	0	7,262,400	181,864	4,553,497	2,430,349	14,246,246	14,246,246
26	HEAT REJECTION SYSTEM	0	0	0	0	0	7,584,600	207,852	5,200,161	2,729,258	15,514,019	15,514,019
2	TOTAL DIRECT COSTS	195,692,200	2,071,388	51,498,805	30,229,776	277,420,781	68,117,142	1,309,649	32,837,514	16,809,401	117,764,057	395,184,838
911	TEMPORARY CONSTRUCTION FACILITIES	0	0	19,941,198	4,722,915	24,664,113	0	0	0	7,380,000	7,380,000	32,044,113
912	CONSTRUCTION TOOLS AND EQUIPMENT	0	0	2,099,073	10,495,367	12,594,441	0	0	0	9,700,000	9,700,000	22,294,441
913	PAYROLL INSURANCE AND TAXES	0	0	14,693,514	0	14,693,514	0	0	0	5,000,000	5,000,000	19,693,514
914	PERMITS, INSURANCE, AND LOCAL TAXES	0	0	0	524,768	524,768	0	0	0	240,000	240,000	764,768
91	CONSTRUCTION SERVICES	0	0	36,733,785	15,743,051	52,476,836	0	0	0	22,320,000	22,320,000	74,796,836
920	REACTOR MODULE ENGINEERING AND SERVICES	21,644,000	0	0	0	21,644,000	0	0	0	0	0	21,644,000
921	PLANT ENGINEERING AND SERVICES	0	0	69,461,779	0	69,461,779	0	0	10,000,000	650,000	10,650,000	80,111,779
922	HOME OFFICE QUALITY ASSURANCE	0	0	962,059	0	962,059	0	0	0	0	0	962,059
923	HOME OFFICE PROJECT & CONSTRUCTION MGMT.	0	0	8,838,534	0	8,838,534	0	0	5,500,000	342,500	5,842,500	14,681,034
92	ENGINEERING AND HOME OFFICE SERVICES	21,644,000	0	79,282,372	0	100,926,372	0	0	15,500,000	992,500	16,492,500	117,418,872
931	FIELD OFFICE EXPENSES	0	0	1,223,790	1,631,720	2,855,510	0	0	0	225,000	225,000	3,080,510
932	FIELD JOB SUPERVISION	0	0	11,218,076	0	11,218,076	0	0	0	4,825,000	4,825,000	16,043,076
933	FIELD QUALITY ASSURANCE/QUALITY CONTROL	0	0	1,019,825	0	1,019,825	0	0	0	0	0	1,019,825
934	PLANT STARTUP AND TEST	0	0	3,671,370	1,631,720	5,303,090	0	0	0	56,250	56,250	5,359,340
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	17,133,062	3,263,440	20,396,502	0	0	0	5,106,250	5,106,250	25,502,752
941	PROJECT MANAGEMENT EXPENSES	0	0	0	0	0	0	0	14,126,169	0	14,126,169	14,126,169
942	FEES, TAXES, AND INSURANCE	0	0	0	0	0	0	0	0	9,725,000	9,725,000	9,725,000
943	SPARE PARTS AND CAPITAL EQUIPMENT	0	0	0	0	0	0	0	0	19,457,246	19,457,246	19,457,246
944	STAFF TRAINING AND STARTUP	0	0	0	0	0	0	0	32,766,683	3,358,269	36,124,952	36,124,952
945	GENERAL & ADMINISTRATIVE	0	0	0	0	0	0	0	7,033,928	3,422,327	10,456,255	10,456,255
94	OWNER'S COSTS	0	0	0	0	0	0	0	53,926,779	35,962,842	89,889,622	89,889,622
9	TOTAL INDIRECT COSTS	21,644,000	0	133,149,219	19,006,491	173,799,710	0	0	69,426,779	64,381,592	133,808,372	307,608,082
	TOTAL BASE CONSTRUCTION COST	217,336,200	2,071,388	184,648,024	49,236,267	451,220,491	68,117,142	1,309,649	102,264,293	81,190,993	251,572,429	702,792,920

TABLE C–2
MHTGR–SC PROTOTYPE PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
211	YARDWORK	0	107,620	2,507,546	1,365,975	3,873,521	756,000	81,462	1,994,479	669,886	3,420,365	7,293,886
212	REACTOR COMPLEX	12,268,000	2,477,743	60,168,170	45,172,024	117,608,194	0	0	0	0	0	117,608,194
213	TURBINE COMPLEX	0	0	0	0	0	3,349,200	383,810	9,878,068	11,213,265	24,440,533	24,440,533
214	OPERATIONS CENTER	0	0	0	0	0	2,145,000	71,503	1,857,579	445,890	4,448,469	4,448,469
215	REMOTE SHUTDOWN BUILDING	0	3,622	89,873	60,097	149,970	0	0	0	0	0	149,970
216	OTHER BUILDINGS	0	26,628	693,295	881,154	1,574,449	520,500	41,808	1,011,411	324,610	1,856,521	3,430,970
21	STRUCTURES & IMPROVEMENTS	12,268,000	2,615,613	63,458,884	47,479,250	123,206,134	6,770,700	578,583	14,741,537	12,653,651	34,165,888	157,372,022
221	REACTOR SYSTEM	144,169,912	75,900	1,870,086	0	146,039,998	0	0	0	0	0	146,039,998
222	VESSEL SYSTEM	132,744,777	165,026	4,044,787	213,720	137,003,284	0	0	0	0	0	137,003,284
223	HEAT TRANSPORT SYSTEM	113,856,594	20,932	550,274	8,200	114,415,068	0	0	0	0	0	114,415,068
224	SHUTDOWN COOLING SYSTEM	16,037,269	28,288	723,543	41,680	16,802,492	0	0	0	0	0	16,802,492
225	SHUTDOWN COOLING WATER SYSTEM	2,705,734	29,373	733,636	867,200	4,306,570	0	0	0	0	0	4,306,570
226	REACTOR CAVITY COOLING SYSTEM	10,571,500	107,970	2,877,494	3,700,800	17,149,794	0	0	0	0	0	17,149,794
227	REACTOR SERVICE SYSTEM	48,952,508	240,839	6,027,724	2,232,559	57,212,791	653,900	8,172	203,763	176,919	1,034,582	58,247,373
228	REACTOR CONTROL, PROTECTION & MONITORING	9,628,747	135,034	3,584,035	1,776,000	14,988,782	187,000	3,735	91,545	0	278,545	15,267,327
229	REACTOR PLANT MISCELLANEOUS	12,912,000	10,000	245,100	500,000	13,657,100	0	0	0	0	0	13,657,100
22	REACTOR PLANT EQUIPMENT	491,579,042	813,362	20,656,679	9,340,159	521,575,880	840,900	11,907	295,308	176,919	1,313,127	522,889,007
231	TURBINE GENERATOR & AUXILIARIES	0	0	0	0	0	76,651,500	337,833	8,232,164	1,641,310	86,524,974	86,524,974
233	MAIN & AUXILIARY STEAM SYSTEM	0	0	0	0	0	8,162,858	164,240	4,106,466	2,598,152	14,867,476	14,867,476
234	FEEDWATER & CONDENSATE SYSTEM	0	0	0	0	0	22,109,670	396,115	9,792,752	2,867,316	34,769,738	34,769,738
235	STARTUP & SHUTDOWN SYSTEM	0	0	0	0	0	0	0	0	0	0	0
236	TURBINE PLANT SAMPLING SYSTEM	0	0	0	0	0	2,196,000	19,473	477,283	0	2,673,283	2,673,283
237	ECA CONTROL, DATA & INSTRUMENTATION	0	5,480	145,822	44,000	189,822	22,860,000	124,143	3,303,445	0	26,163,445	26,353,267
23	TURBINE PLANT EQUIPMENT	0	5,480	145,822	44,000	189,822	131,980,028	1,041,804	25,912,110	7,106,778	164,998,916	165,188,738
241	SWITCHGEAR	0	13,735	370,158	0	370,158	6,360,380	23,430	631,439	0	6,991,819	7,361,977
242	STATION SERVICE EQUIPMENT	6,108,600	39,048	1,052,342	24,544	7,185,486	6,162,370	22,670	602,396	47,580	6,812,346	13,997,832
243	SWITCHBOARDS	0	834	22,476	0	22,476	3,989,600	3,512	94,648	0	4,084,248	4,106,724
244	PROTECTIVE EQUIPMENT	0	0	0	0	0	137,200	11,061	298,635	55,000	490,835	490,835
245	ELECTRIC STRUCTURES & WIRING CONTAINERS	0	448,724	12,093,111	0	12,093,111	0	49,971	1,346,718	990,320	2,337,038	14,430,149
246	POWER AND CONTROL WIRING	0	288,418	7,772,866	0	7,772,866	0	83,569	2,252,184	4,343,792	6,595,976	14,368,842
24	ELECTRIC PLANT EQUIPMENT	6,108,600	790,759	21,310,953	24,544	27,444,097	16,649,550	194,233	5,226,020	5,436,692	27,312,262	54,756,359

TABLE C–2
MHTGR–SC PROTOTYPE PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
251	TRANSPORTATION AND LIFT EQUIPMENT	1,449,000	11,392	279,218	36,000	1,764,218	762,700	4,204	103,040	10,738	876,478	2,640,696
252	AIR, WATER, AND STEAM SERVICE SYSTEM	1,633,040	300,917	7,510,348	2,328,811	11,472,199	8,636,300	342,301	8,405,617	3,567,829	20,609,746	32,081,945
253	COMMUNICATIONS AND SECURITY EQUIPMENT	0	11,014	293,083	2,102,440	2,395,523	1,043,000	45,366	1,222,614	0	2,265,614	4,661,137
254	FURNISHINGS AND FIXTURES	198,000	1,968	52,505	1,112,850	1,363,355	458,750	3,501	85,810	0	544,560	1,907,915
25	MISCELLANEOUS PLANT EQUIPMENT	3,280,040	325,291	8,135,154	5,580,101	16,995,295	10,900,750	395,372	9,817,081	3,578,567	24,296,398	41,291,693
261	CIRCULATING AND SERVICE WATER PUMPHOUSE	0	0	0	0	0	3,600	12,762	307,573	198,768	509,941	509,941
262	ECA COOLING WATER SYSTEMS	0	0	0	0	0	1,281,600	65,339	1,645,439	798,100	3,725,139	3,725,139
263	CIRCULATING AND SERVICE WATER SYSTEM	0	0	0	0	0	14,142,800	320,311	8,021,049	4,844,098	27,007,947	27,007,947
26	HEAT REJECTION SYSTEM	0	0	0	0	0	15,428,000	398,412	9,974,061	5,840,966	31,243,027	31,243,027
2	TOTAL DIRECT COSTS	513,235,682	4,550,505	113,707,492	62,468,054	689,411,228	182,569,928	2,620,311	65,966,117	36,793,573	285,329,618	974,740,846
911	TEMPORARY CONSTRUCTION FACILITIES	0	0	39,429,629	9,338,596	48,768,225	0	0	0	7,380,000	7,380,000	56,148,225
912	CONSTRUCTION TOOLS AND EQUIPMENT	0	0	4,150,467	20,752,456	24,902,923	0	0	0	9,700,000	9,700,000	34,602,923
913	PAYROLL INSURANCE AND TAXES	0	0	29,053,411	0	29,053,411	0	0	0	20,000,000	20,000,000	49,053,411
914	PERMITS, INSURANCE, AND LOCAL TAXES	0	0	0	1,037,622	1,037,622	0	0	0	960,000	960,000	1,997,622
91	CONSTRUCTION SERVICES	0	0	72,633,526	31,128,654	103,762,181	0	0	0	38,040,000	38,040,000	141,802,181
920	REACTOR MODULE ENGINEERING AND SERVICES	52,719,324	0	0	0	52,719,324	0	0	0	0	0	52,719,324
921	PLANT ENGINEERING AND SERVICES	0	0	88,320,347	0	88,320,347	0	0	10,000,000	2,600,000	12,600,000	100,920,347
922	HOME OFFICE QUALITY ASSURANCE	0	0	1,610,678	0	1,610,678	0	0	0	0	0	1,610,678
923	HOME OFFICE PROJECT & CONSTRUCTION MGMT.	0	0	14,466,104	0	14,466,104	0	0	5,500,000	1,370,000	6,870,000	21,366,104
92	ENGINEERING AND HOME OFFICE SERVICES	52,719,324	0	104,427,129	0	157,146,453	0	0	15,500,000	3,970,000	19,470,000	176,616,453
931	FIELD OFFICE EXPENSES	0	0	2,605,218	3,473,624	6,078,842	0	0	0	900,000	900,000	6,978,842
932	FIELD JOB SUPERVISION	0	0	23,881,163	0	23,881,163	0	0	0	19,300,000	19,300,000	43,181,163
933	FIELD QUALITY ASSURANCE/QUALITY CONTROL	0	0	2,171,015	0	2,171,015	0	0	0	0	0	2,171,015
934	PLANT STARTUP AND TEST	0	0	7,815,653	3,473,624	11,289,277	0	0	0	225,000	225,000	11,514,277
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	36,473,049	6,947,248	43,420,297	0	0	0	20,425,000	20,425,000	63,845,297
941	PROJECT MANAGEMENT EXPENSES	0	0	0	0	0	0	0	21,969,402	0	21,969,402	21,969,402
942	FEES, TAXES, AND INSURANCE	0	0	0	0	0	0	0	0	52,150,000	52,150,000	52,150,000
943	SPARE PARTS AND CAPITAL EQUIPMENT	0	0	0	0	0	0	0	0	31,705,610	31,705,610	31,705,610
944	STAFF TRAINING AND STARTUP	0	0	0	0	0	0	0	49,835,646	7,312,868	57,148,514	57,148,514
945	GENERAL & ADMINISTRATIVE	0	0	0	0	0	0	0	10,770,757	5,852,772	16,623,529	16,623,529
94	OWNER'S COSTS	0	0	0	0	0	0	0	82,575,805	97,021,250	179,597,055	179,597,055
9	TOTAL INDIRECT COSTS	52,719,324	0	213,533,705	38,075,902	304,328,931	0	0	98,075,805	159,456,250	257,532,055	561,860,986
	TOTAL BASE CONSTRUCTION COST	565,955,005	4,550,505	327,241,197	100,543,956	993,740,158	182,569,928	2,620,311	164,041,922	196,249,823	542,861,673	1,536,601,831

TABLE C–3
MHTGR–SC REPLICA PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
211	YARDWORK	0	105,468	2,457,403	1,365,975	3,823,378	756,000	79,834	1,954,619	669,886	3,380,505	7,203,883
212	REACTOR COMPLEX	12,268,000	2,316,760	56,312,858	45,172,024	113,752,882	0	0	0	0	0	113,752,882
213	TURBINE COMPLEX	0	0	0	0	0	3,349,200	358,683	9,229,940	11,213,265	23,792,405	23,792,405
214	OPERATIONS CENTER	0	0	0	0	0	2,145,000	70,074	1,820,454	445,890	4,411,344	4,411,344
215	REMOTE SHUTDOWN BUILDING	0	3,550	88,068	60,097	148,185	0	0	0	0	0	148,185
216	OTHER BUILDINGS	0	26,098	679,488	881,154	1,560,642	520,500	40,976	991,284	324,610	1,836,394	3,397,036
21	STRUCTURES & IMPROVEMENTS	12,268,000	2,453,876	59,537,837	47,479,250	119,285,087	6,770,700	549,567	13,996,297	12,653,651	33,420,648	152,705,735
221	REACTOR SYSTEM	123,572,695	70,340	1,733,160	0	125,305,855	0	0	0	0	0	125,305,855
222	VESSEL SYSTEM	123,063,199	152,740	3,743,680	213,720	127,020,579	0	0	0	0	0	127,020,579
223	HEAT TRANSPORT SYSTEM	99,197,852	19,480	512,093	8,200	99,718,145	0	0	0	0	0	99,718,145
224	SHUTDOWN COOLING SYSTEM	13,512,011	26,258	671,658	41,680	14,225,349	0	0	0	0	0	14,225,349
225	SHUTDOWN COOLING WATER SYSTEM	2,440,434	27,186	679,013	867,200	3,986,647	0	0	0	0	0	3,986,647
226	REACTOR CAVITY COOLING SYSTEM	9,151,626	99,932	2,663,275	3,700,800	15,515,701	0	0	0	0	0	15,515,701
227	REACTOR SERVICE SYSTEM	43,647,621	227,600	5,695,692	2,232,559	51,575,872	653,900	8,009	199,700	176,919	1,030,519	52,606,391
228	REACTOR CONTROL, PROTECTION & MONITORING	8,497,110	125,560	3,333,420	1,776,000	13,606,530	187,000	3,660	89,707	0	276,707	13,883,237
229	REACTOR PLANT MISCELLANEOUS	10,191,800	9,800	240,198	500,000	10,931,998	0	0	0	0	0	10,931,998
22	REACTOR PLANT EQUIPMENT	433,274,347	758,926	19,272,169	9,340,159	461,886,675	840,900	11,669	289,407	176,919	1,307,226	463,193,901
231	TURBINE GENERATOR & AUXILIARIES	0	0	0	0	0	69,903,500	313,153	7,631,092	1,641,310	79,175,902	79,175,902
233	MAIN & AUXILIARY STEAM SYSTEM	0	0	0	0	0	8,162,858	152,022	3,800,973	2,598,152	14,561,983	14,561,983
234	FEEDWATER & CONDENSATE SYSTEM	0	0	0	0	0	22,109,670	366,954	9,071,764	2,867,316	34,048,750	34,048,750
235	STARTUP & SHUTDOWN SYSTEM	0	0	0	0	0	0	0	0	0	0	0
236	TURBINE PLANT SAMPLING SYSTEM	0	0	0	0	0	2,196,000	18,024	441,768	0	2,637,768	2,637,768
237	ECA CONTROL, DATA & INSTRUMENTATION	0	5,370	142,896	44,000	186,896	22,860,000	114,901	3,057,516	0	25,917,516	26,104,412
23	TURBINE PLANT EQUIPMENT	0	5,370	142,896	44,000	186,896	125,232,028	965,054	24,003,113	7,106,778	156,341,919	156,528,815
241	SWITCHGEAR	0	12,713	342,615	0	342,615	6,360,380	21,702	584,870	0	6,945,250	7,287,865
242	STATION SERVICE EQUIPMENT	6,106,600	36,143	974,054	24,544	7,107,198	6,162,370	21,516	571,471	47,580	6,781,421	13,888,619
243	SWITCHBOARDS	0	773	20,834	0	20,834	3,969,600	3,250	87,589	0	4,077,189	4,098,023
244	PROTECTIVE EQUIPMENT	0	0	0	0	0	137,200	10,841	292,166	55,000	484,366	484,366
245	ELECTRIC STRUCTURES & WIRING CONTAINERS	0	415,319	11,192,847	0	11,192,847	0	46,251	1,246,465	990,320	2,236,785	13,429,632
246	POWER AND CONTROL WIRING	0	266,948	7,194,249	0	7,194,249	0	77,349	2,084,556	4,343,792	6,428,348	13,622,597
24	ELECTRIC PLANT EQUIPMENT	6,106,600	731,896	19,724,599	24,544	25,857,743	16,649,550	180,909	4,867,117	5,436,692	26,953,359	52,811,102

TABLE C–3
MHTGR–SC REPLICA PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
251	TRANSPORTATION AND LIFT EQUIPMENT	1,449,000	10,840	265,689	36,000	1,750,689	762,700	4,075	99,878	10,738	873,316	2,624,005
252	AIR, WATER, AND STEAM SERVICE SYSTEM	1,633,040	292,656	7,304,809	2,328,511	11,266,660	8,636,300	333,093	8,178,437	3,567,829	20,382,566	31,649,226
253	COMMUNICATIONS AND SECURITY EQUIPMENT	0	10,795	287,255	2,102,440	2,389,695	1,043,000	43,834	1,181,326	0	2,224,326	4,614,021
254	FURNISHINGS AND FIXTURES	196,000	1,928	51,441	1,112,850	1,362,291	458,750	3,432	84,120	0	542,870	1,905,161
25	MISCELLANEOUS PLANT EQUIPMENT	3,280,040	316,219	7,909,194	5,580,101	16,769,335	10,900,750	384,434	9,543,761	3,578,567	24,023,078	40,792,413
261	CIRCULATING AND SERVICE WATER PUMPHOUSE	0	0	0	0	0	3,600	11,811	284,648	198,768	487,016	487,016
262	ECA COOLING WATER SYSTEMS	0	0	0	0	0	1,281,600	60,475	1,522,951	796,100	3,602,651	3,602,651
263	CIRCULATING AND SERVICE WATER SYSTEM	0	0	0	0	0	14,142,800	296,616	7,427,618	4,844,098	26,414,516	26,414,516
26	HEAT REJECTION SYSTEM	0	0	0	0	0	15,428,000	368,902	9,235,217	5,840,966	30,504,183	30,504,183
2	TOTAL DIRECT COSTS	454,930,967	4,266,287	106,586,695	62,468,054	623,985,736	175,821,928	2,460,535	61,934,912	36,793,573	274,550,413	898,536,149
911	TEMPORARY CONSTRUCTION FACILITIES	0	0	30,772,321	7,288,181	38,060,502	0	0	0	7,380,000	7,380,000	45,440,502
912	CONSTRUCTION TOOLS AND EQUIPMENT	0	0	3,239,192	16,196,958	19,436,150	0	0	0	9,700,000	9,700,000	29,136,150
913	PAYROLL INSURANCE AND TAXES	0	0	22,674,342	0	22,674,342	0	0	0	20,000,000	20,000,000	42,674,342
914	PERMITS, INSURANCE, AND LOCAL TAXES	0	0	0	809,796	809,796	0	0	0	960,000	960,000	1,769,796
91	CONSTRUCTION SERVICES	0	0	56,685,854	24,293,937	80,979,791	0	0	0	38,040,000	38,040,000	119,019,791
920	REACTOR MODULE ENGINEERING AND SERVICES	30,098,323	0	0	0	30,098,323	0	0	0	0	0	30,098,323
921	PLANT ENGINEERING AND SERVICES	0	0	29,182,860	0	29,182,860	0	0	0	2,600,000	2,600,000	31,782,860
922	HOME OFFICE QUALITY ASSURANCE	0	0	972,762	0	972,762	0	0	0	0	0	972,762
923	HOME OFFICE PROJECT & CONSTRUCTION MGMT.	0	0	8,754,858	0	8,754,858	0	0	0	1,370,000	1,370,000	10,124,858
92	ENGINEERING AND HOME OFFICE SERVICES	30,098,323	0	38,910,481	0	69,008,803	0	0	0	3,970,000	3,970,000	72,978,803
931	FIELD OFFICE EXPENSES	0	0	2,260,999	3,014,665	5,275,664	0	0	0	900,000	900,000	6,175,664
932	FIELD JOB SUPERVISION	0	0	20,725,823	0	20,725,823	0	0	0	19,300,000	19,300,000	40,025,823
933	FIELD QUALITY ASSURANCE/QUALITY CONTROL	0	0	1,884,166	0	1,884,166	0	0	0	0	0	1,884,166
934	PLANT STARTUP AND TEST	0	0	6,782,997	3,014,665	9,797,662	0	0	0	225,000	225,000	10,022,662
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	31,653,985	6,029,330	37,683,315	0	0	0	20,425,000	20,425,000	58,108,315
941	PROJECT MANAGEMENT EXPENSES	0	0	0	0	0	0	0	9,672,650	0	9,672,650	9,672,650
942	FEES, TAXES, AND INSURANCE	0	0	0	0	0	0	0	0	57,550,000	57,550,000	57,550,000
943	SPARE PARTS AND CAPITAL EQUIPMENT	0	0	0	0	0	0	0	0	31,112,018	31,112,018	31,112,018
944	STAFF TRAINING AND STARTUP	0	0	0	0	0	0	0	45,321,651	6,718,074	52,039,725	52,039,725
945	GENERAL & ADMINISTRATIVE	0	0	0	0	0	0	0	8,249,145	5,674,514	13,923,659	13,923,659
94	OWNER'S COSTS	0	0	0	0	0	0	0	63,243,446	101,054,605	164,298,051	164,298,051
9	TOTAL INDIRECT COSTS	30,098,323	0	127,250,319	30,323,268	187,671,910	0	0	63,243,446	163,489,605	226,733,051	414,404,961
	TOTAL BASE CONSTRUCTION COST	485,029,310	4,266,287	233,837,014	92,791,322	811,657,646	175,821,928	2,460,535	125,178,358	200,283,178	501,283,464	1,312,941,110

TABLE C–4
MHTGR–SC TARGET PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
211	YARDWORK	0	101,686	2,369,286	1,365,975	3,735,261	756,000	76,972	1,884,544	669,886	3,310,430	7,045,691
212	REACTOR COMPLEX	12,268,000	2,235,616	54,293,644	45,172,024	111,733,668	0	0	0	0	0	111,733,668
213	TURBINE COMPLEX	0	0	0	0	0	3,349,200	345,826	8,899,090	11,213,265	23,461,555	23,461,555
214	OPERATIONS CENTER	0	0	0	0	0	2,145,000	67,560	1,755,144	445,890	4,346,034	4,346,034
215	REMOTE SHUTDOWN BUILDING	0	3,423	84,936	60,097	145,033	0	0	0	0	0	145,033
216	OTHER BUILDINGS	0	25,159	655,044	881,154	1,536,198	520,500	39,502	955,619	324,610	1,800,729	3,336,927
21	STRUCTURES & IMPROVEMENTS	12,268,000	2,365,884	57,402,910	47,479,250	117,150,160	6,770,700	529,860	13,494,397	12,653,651	32,918,748	150,068,908
221	REACTOR SYSTEM	106,974,580	67,817	1,670,994	0	110,645,574	0	0	0	0	0	110,645,574
222	VESSEL SYSTEM	116,979,017	147,260	3,609,342	213,720	120,802,079	0	0	0	0	0	120,802,079
223	HEAT TRANSPORT SYSTEM	89,711,519	18,782	493,744	8,200	90,213,463	0	0	0	0	0	90,213,463
224	SHUTDOWN COOLING SYSTEM	12,209,772	25,316	647,561	41,680	12,899,013	0	0	0	0	0	12,899,013
225	SHUTDOWN COOLING WATER SYSTEM	2,149,714	26,212	654,687	867,200	3,671,601	0	0	0	0	0	3,671,601
226	REACTOR CAVITY COOLING SYSTEM	8,061,429	96,349	2,567,783	3,700,800	14,330,012	0	0	0	0	0	14,330,012
227	REACTOR SERVICE SYSTEM	39,125,611	219,439	5,491,463	2,232,559	46,849,633	653,900	7,721	192,516	176,919	1,023,335	47,872,968
228	REACTOR CONTROL, PROTECTION & MONITORING	7,497,240	121,067	3,213,898	1,776,000	12,487,138	187,000	3,529	86,496	0	273,496	12,760,634
229	REACTOR PLANT MISCELLANEOUS	9,299,678	9,449	231,595	500,000	10,031,273	0	0	0	0	0	10,031,273
22	REACTOR PLANT EQUIPMENT	394,008,560	731,711	18,581,067	9,340,159	421,929,786	840,900	11,250	279,012	176,919	1,296,831	423,226,617
231	TURBINE GENERATOR & AUXILIARIES	0	0	0	0	0	69,903,500	301,923	7,367,431	1,641,310	78,902,241	78,902,241
233	MAIN & AUXILIARY STEAM SYSTEM	0	0	0	0	0	8,162,858	146,572	3,664,710	2,598,152	14,425,720	14,425,720
234	FEEDWATER & CONDENSATE SYSTEM	0	0	0	0	0	22,109,870	353,806	8,746,722	2,867,316	33,723,708	33,723,708
235	STARTUP & SHUTDOWN SYSTEM	0	0	0	0	0	0	0	0	0	0	0
236	TURBINE PLANT SAMPLING SYSTEM	0	0	0	0	0	2,196,000	17,377	425,910	0	2,621,910	2,621,910
237	ECA CONTROL, DATA & INSTRUMENTATION	0	5,178	137,787	44,000	181,787	22,860,000	110,781	2,947,882	0	25,807,882	25,989,669
23	TURBINE PLANT EQUIPMENT	0	5,178	137,787	44,000	181,787	125,232,028	930,459	23,142,655	7,106,778	155,481,461	155,663,248
241	SWITCHGEAR	0	12,257	330,327	0	330,327	6,360,380	20,921	563,820	0	6,924,200	7,254,527
242	STATION SERVICE EQUIPMENT	6,108,600	34,843	939,018	24,544	7,072,162	6,162,370	20,746	551,012	47,580	6,760,962	13,833,124
243	SWITCHBOARDS	0	744	20,051	0	20,051	3,989,600	3,133	84,434	0	4,074,034	4,094,085
244	PROTECTIVE EQUIPMENT	0	0	0	0	0	137,200	10,450	281,629	55,000	473,829	473,829
245	ELECTRIC STRUCTURES & WIRING CONTAINERS	0	400,427	10,791,508	0	10,791,508	0	44,592	1,201,755	990,320	2,192,075	12,983,583
246	POWER AND CONTROL WIRING	0	257,376	6,936,284	0	6,936,284	0	74,573	2,009,742	4,343,792	6,353,534	13,289,818
24	ELECTRIC PLANT EQUIPMENT	6,108,600	705,647	19,017,188	24,544	25,150,332	16,649,550	174,415	4,692,392	5,436,692	26,778,634	51,928,966

TABLE C–4
MHTGR–SC TARGET PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
251	TRANSPORTATION AND LIFT EQUIPMENT	1,449,000	10,455	256,254	36,000	1,741,254	762,700	3,929	96,300	10,738	869,738	2,610,992
252	AIR, WATER, AND STEAM SERVICE SYSTEM	1,633,040	282,164	7,042,928	2,328,811	11,004,779	8,636,300	321,143	7,885,025	3,567,829	20,089,154	31,093,933
253	COMMUNICATIONS AND SECURITY EQUIPMENT	0	10,406	276,904	2,102,440	2,379,344	1,043,000	42,263	1,138,988	0	2,181,988	4,561,332
254	FURNISHINGS AND FIXTURES	196,000	1,858	49,571	1,112,850	1,360,421	458,750	3,308	81,080	0	539,830	1,900,251
25	MISCELLANEOUS PLANT EQUIPMENT	3,280,040	304,883	7,625,657	5,580,101	16,485,798	10,900,750	370,643	9,201,393	3,578,557	23,680,710	40,166,508
261	CIRCULATING AND SERVICE WATER PUMPHOUSE	0	0	0	0	0	3,600	11,387	274,428	198,768	476,796	476,796
262	ECA COOLING WATER SYSTEMS	0	0	0	0	0	1,281,600	58,309	1,466,403	798,100	3,548,103	3,548,103
263	CIRCULATING AND SERVICE WATER SYSTEM	0	0	0	0	0	14,142,800	285,976	7,161,171	4,844,098	26,148,069	26,148,069
26	HEAT REJECTION SYSTEM	0	0	0	0	0	15,428,000	355,672	8,904,002	5,840,966	30,172,968	30,172,968
2	TOTAL DIRECT COSTS	415,665,200	4,113,303	102,764,609	62,468,054	580,897,863	175,821,928	2,372,299	59,713,851	36,793,573	272,329,352	853,227,215
911	TEMPORARY CONSTRUCTION FACILITIES	0	0	29,871,837	7,074,909	36,946,746	0	0	0	7,380,000	7,380,000	44,326,746
912	CONSTRUCTION TOOLS AND EQUIPMENT	0	0	3,144,404	15,722,020	18,866,423	0	0	0	9,700,000	9,700,000	28,566,423
913	PAYROLL INSURANCE AND TAXES	0	0	22,010,827	0	22,010,827	0	0	0	20,000,000	20,000,000	42,010,827
914	PERMITS, INSURANCE, AND LOCAL TAXES	0	0	0	786,101	786,101	0	0	0	960,000	960,000	1,746,101
91	CONSTRUCTION SERVICES	0	0	55,027,068	23,583,029	78,610,096	0	0	0	38,040,000	38,040,000	116,650,096
920	REACTOR MODULE ENGINEERING AND SERVICES	17,117,918	0	0	0	17,117,918	0	0	0	0	0	17,117,918
921	PLANT ENGINEERING AND SERVICES	0	0	28,963,190	0	28,963,190	0	0	0	2,600,000	2,600,000	31,563,190
922	HOME OFFICE QUALITY ASSURANCE	0	0	965,440	0	965,440	0	0	0	0	0	965,440
923	HOME OFFICE PROJECT & CONSTRUCTION MGMT.	0	0	8,688,957	0	8,688,957	0	0	0	1,370,000	1,370,000	10,058,957
92	ENGINEERING AND HOME OFFICE SERVICES	17,117,918	0	38,617,587	0	55,735,505	0	0	0	3,970,000	3,970,000	59,705,505
931	FIELD OFFICE EXPENSES	0	0	2,185,322	2,913,762	5,099,084	0	0	0	900,000	900,000	5,999,084
932	FIELD JOB SUPERVISION	0	0	20,032,115	0	20,032,115	0	0	0	19,300,000	19,300,000	39,332,115
933	FIELD QUALITY ASSURANCE/QUALITY CONTROL	0	0	1,821,101	0	1,821,101	0	0	0	0	0	1,821,101
934	PLANT STARTUP AND TEST	0	0	6,555,965	2,913,762	9,469,727	0	0	0	225,000	225,000	9,694,727
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	30,594,502	5,827,524	36,422,027	0	0	0	20,425,000	20,425,000	56,847,027
941	PROJECT MANAGEMENT EXPENSES	0	0	0	0	0	0	0	7,917,168	0	7,917,168	7,917,168
942	FEES, TAXES, AND INSURANCE	0	0	0	0	0	0	0	0	50,760,000	50,760,000	50,760,000
943	SPARE PARTS AND CAPITAL EQUIPMENT	0	0	0	0	0	0	0	0	30,332,019	30,332,019	30,332,019
944	STAFF TRAINING AND STARTUP	0	0	0	0	0	0	0	27,832,809	4,542,625	32,375,433	32,375,433
945	GENERAL & ADMINISTRATIVE	0	0	0	0	0	0	0	5,362,496	5,231,197	10,593,693	10,593,693
94	OWNER'S COSTS	0	0	0	0	0	0	0	41,112,472	90,865,840	131,978,313	131,978,313
9	TOTAL INDIRECT COSTS	17,117,918	0	124,239,158	29,410,554	170,767,629	0	0	41,112,472	153,300,840	194,413,313	365,180,942
	TOTAL BASE CONSTRUCTION COST	432,783,118	4,113,303	227,003,767	91,878,608	751,665,492	175,821,928	2,372,299	100,826,323	190,094,413	466,742,665	1,218,408,156

TABLE C–5
MHTGR–GT/IC LEAD MODULE BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
211	YARDWORK	0	107,836	2,512,362	1,365,975	3,878,337	756,000	69,432	1,706,303	578,696	3,042,999	6,921,326
212	REACTOR COMPLEX	3,755,500	1,180,066	28,679,379	20,971,177	53,406,056	0	0	0	0	0	53,406,056
213	TURBINE COMPLEX	0	0	0	0	0	1,376,895	144,647	3,717,664	3,472,152	8,566,701	8,566,701
214	OPERATIONS CENTER	0	0	0	0	0	2,145,000	71,503	1,857,579	445,890	4,448,469	4,448,469
215	REMOTE SHUTDOWN BUILDING	0	3,622	89,873	59,877	149,750	0	0	0	0	0	149,750
216	OTHER BUILDINGS	0	26,628	693,295	877,809	1,571,104	520,500	41,808	1,011,411	324,610	1,856,521	3,427,625
21	STRUCTURES & IMPROVEMENTS	3,755,500	1,318,152	31,974,909	23,274,838	59,005,247	4,798,395	327,390	8,294,977	4,821,338	17,914,680	76,919,927
221	REACTOR SYSTEM	52,048,000	22,988	567,221	0	52,615,221	0	0	0	0	0	52,615,221
222	VESSEL SYSTEM	43,519,750	49,960	1,224,520	84,388	44,828,658	0	0	0	0	0	44,828,658
223	HEAT TRANSPORT SYSTEM	62,598,000	7,852	208,273	2,500	62,808,773	0	0	0	0	0	62,808,773
224	SHUTDOWN COOLING SYSTEM	5,711,000	9,132	234,057	10,720	5,955,777	0	0	0	0	0	5,955,777
225	SHUTDOWN COOLING WATER SYSTEM	740,000	11,995	299,748	319,780	1,359,528	0	0	0	0	0	1,359,528
226	REACTOR CAVITY COOLING SYSTEM	3,200,000	31,049	827,481	920,170	4,947,651	0	0	0	0	0	4,947,651
227	REACTOR SERVICE SYSTEM	37,176,400	143,684	3,588,031	1,031,324	41,795,755	4,895,700	19,673	493,123	350,252	5,739,075	47,534,830
228	REACTOR CONTROL, PROTECTION & MONITORING	2,929,000	44,019	1,173,024	925,120	5,027,144	187,000	3,735	91,545	0	278,545	5,305,689
229	REACTOR PLANT MISCELLANEOUS	11,682,000	10,000	245,100	500,000	12,427,100	0	0	0	0	0	12,427,100
22	REACTOR PLANT EQUIPMENT	219,604,150	330,679	8,365,455	3,794,002	231,763,607	5,082,700	23,408	584,668	350,252	6,017,620	237,781,227
231	TURBINE GENERATOR & AUXILIARIES	25,670,000	0	0	0	25,670,000	87,500	55,838	1,367,835	135,947	1,591,282	27,261,282
233	MAIN & AUXILIARY STEAM SYSTEM	0	0	0	0	0	2,048,996	34,212	855,102	220,428	3,124,526	3,124,526
234	FEEDWATER & CONDENSATE SYSTEM	0	0	0	0	0	40,897,162	73,923	1,845,986	1,917,600	44,660,748	44,660,748
235	STARTUP & SHUTDOWN SYSTEM	0	0	0	0	0	0	0	0	0	0	0
236	TURBINE PLANT SAMPLING SYSTEM	0	0	0	0	0	0	0	0	0	0	0
237	ECA CONTROL, DATA & INSTRUMENTATION	0	5,480	145,822	44,000	189,822	5,715,000	35,700	949,977	0	6,664,977	6,854,799
23	TURBINE PLANT EQUIPMENT	25,670,000	5,480	145,822	44,000	25,859,822	48,748,658	199,673	5,018,900	2,273,975	56,041,533	81,901,355
241	SWITCHGEAR	0	3,950	106,453	0	106,453	1,740,800	6,930	186,765	0	1,927,265	2,033,718
242	STATION SERVICE EQUIPMENT	1,527,150	11,229	302,621	6,136	1,835,907	2,967,040	13,528	356,020	47,580	3,370,640	5,206,547
243	SWITCHBOARDS	0	240	6,468	0	6,468	996,800	1,010	27,220	0	1,024,020	1,030,488
244	PROTECTIVE EQUIPMENT	0	0	0	0	0	101,200	10,833	291,951	55,000	448,151	448,151
245	ELECTRIC STRUCTURES & WIRING CONTAINERS	0	134,465	3,623,833	0	3,623,833	0	14,370	387,272	247,580	634,852	4,258,685
246	POWER AND CONTROL WIRING	0	83,935	2,262,048	0	2,262,048	0	24,032	647,665	1,065,948	1,733,613	3,995,661
24	ELECTRIC PLANT EQUIPMENT	1,527,150	233,819	6,301,423	6,136	7,834,709	5,805,540	70,703	1,896,893	1,436,108	9,138,541	16,973,250

TABLE C–5
MHTGR–GT/IC LEAD MODULE BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
251	TRANSPORTATION AND LIFT EQUIPMENT	970,500	7,180	175,982	9,000	1,155,482	543,000	3,406	83,481	10,738	637,219	1,792,701
252	AIR, WATER, AND STEAM SERVICE SYSTEM	815,300	271,552	6,785,948	969,021	8,570,269	7,900,850	306,286	7,506,252	3,383,689	18,792,791	27,363,060
253	COMMUNICATIONS AND SECURITY EQUIPMENT	0	11,214	298,405	2,070,940	2,369,345	962,000	37,191	1,002,298	0	1,964,298	4,333,643
254	FURNISHINGS AND FIXTURES	196,000	1,968	52,505	1,112,850	1,363,355	454,500	3,501	85,810	0	540,310	1,903,665
25	MISCELLANEOUS PLANT EQUIPMENT	1,983,800	291,914	7,312,840	4,161,811	13,458,451	9,860,350	350,384	8,679,841	3,394,427	21,934,618	35,393,069
261	CIRCULATING AND SERVICE WATER PUMPHOUSE	0	0	0	0	0	1,800	7,198	173,474	99,384	274,658	274,658
262	ECA COOLING WATER SYSTEMS	0	0	0	0	0	320,900	18,790	473,190	199,525	993,615	993,615
263	CIRCULATING AND SERVICE WATER SYSTEM	0	0	0	0	0	2,535,500	102,040	2,529,930	1,401,663	6,467,093	6,467,093
26	HEAT REJECTION SYSTEM	0	0	0	0	0	2,858,200	128,028	3,176,594	1,700,572	7,735,366	7,735,366
2	TOTAL DIRECT COSTS	252,540,600	2,180,044	54,100,449	31,280,787	337,921,836	77,153,813	1,099,586	27,651,873	15,976,872	120,782,358	458,704,194
911	TEMPORARY CONSTRUCTION FACILITIES	0	0	20,560,830	4,869,670	25,430,500	0	0	0	7,380,000	7,380,000	32,810,500
912	CONSTRUCTION TOOLS AND EQUIPMENT	0	0	2,164,298	10,821,489	12,985,787	0	0	0	9,700,000	9,700,000	22,685,787
913	PAYROLL INSURANCE AND TAXES	0	0	15,150,065	0	15,150,065	0	0	0	5,000,000	5,000,000	20,150,065
914	PERMITS, INSURANCE, AND LOCAL TAXES	0	0	0	541,074	541,074	0	0	0	240,000	240,000	781,074
91	CONSTRUCTION SERVICES	0	0	37,875,213	16,232,234	54,107,447	0	0	0	22,320,000	22,320,000	76,427,447
920	REACTOR MODULE ENGINEERING AND SERVICES	21,644,000	0	0	0	21,644,000	0	0	0	0	0	21,644,000
921	PLANT ENGINEERING AND SERVICES	0	0	69,984,196	0	69,984,196	0	0	10,000,000	650,000	10,650,000	80,634,196
922	HOME OFFICE QUALITY ASSURANCE	0	0	999,473	0	999,473	0	0	0	0	0	999,473
923	HOME OFFICE PROJECT & CONSTRUCTION MGMT.	0	0	8,995,259	0	8,995,259	0	0	5,500,000	342,500	5,842,500	14,837,759
92	ENGINEERING AND HOME OFFICE SERVICES	21,644,000	0	79,978,928	0	101,622,928	0	0	15,500,000	992,500	16,492,500	118,115,428
931	FIELD OFFICE EXPENSES	0	0	1,275,664	1,700,886	2,976,550	0	0	0	225,000	225,000	3,201,550
932	FIELD JOB SUPERVISION	0	0	11,693,590	0	11,693,590	0	0	0	4,825,000	4,825,000	16,518,590
933	FIELD QUALITY ASSURANCE/QUALITY CONTROL	0	0	1,063,054	0	1,063,054	0	0	0	0	0	1,063,054
934	PLANT STARTUP AND TEST	0	0	3,826,993	1,700,886	5,527,879	0	0	0	56,250	56,250	5,584,129
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	17,859,301	3,401,772	21,261,072	0	0	0	5,106,250	5,106,250	26,367,322
941	PROJECT MANAGEMENT EXPENSES	0	0	0	0	0	0	0	14,126,169	0	14,126,169	14,126,169
942	FEES, TAXES, AND INSURANCE	0	0	0	0	0	0	0	0	9,725,000	9,725,000	9,725,000
943	SPARE PARTS AND CAPITAL EQUIPMENT	0	0	0	0	0	0	0	0	23,600,181	23,600,181	23,600,181
944	STAFF TRAINING AND STARTUP	0	0	0	0	0	0	0	32,766,683	3,588,205	36,354,888	36,354,888
945	GENERAL & ADMINISTRATIVE	0	0	0	0	0	0	0	7,033,928	4,078,258	11,112,186	11,112,186
94	OWNER'S COSTS	0	0	0	0	0	0	0	53,926,779	40,991,644	94,918,423	94,918,423
9	TOTAL INDIRECT COSTS	21,644,000	0	135,713,442	19,634,006	176,991,448	0	0	69,426,779	69,410,394	138,837,173	315,828,621
	TOTAL BASE CONSTRUCTION COST	274,184,600	2,180,044	189,813,891	50,914,793	514,913,284	77,153,813	1,099,586	97,078,652	85,387,066	259,619,531	774,532,815

TABLE C–6
MHTGR–GT/IC PROTOTYPE PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
211	YARDWORK	0	107,836	2,512,362	1,365,975	3,878,337	756,000	69,432	1,706,303	576,686	3,042,989	6,921,326
212	REACTOR COMPLEX	12,268,000	2,815,510	68,177,411	49,701,042	130,146,453	0	0	0	0	0	130,146,453
213	TURBINE COMPLEX	0	0	0	0	0	3,349,200	353,338	9,127,993	10,271,010	22,748,203	22,748,203
214	OPERATIONS CENTER	0	0	0	0	0	2,145,000	71,503	1,857,579	445,890	4,448,469	4,448,469
215	REMOTE SHUTDOWN BUILDING	0	3,622	89,873	59,877	149,750	0	0	0	0	0	149,750
216	OTHER BUILDINGS	0	26,628	693,295	877,809	1,571,104	520,500	41,808	1,011,411	324,610	1,856,521	3,427,625
21	STRUCTURES & IMPROVEMENTS	12,268,000	2,953,596	71,472,941	52,004,703	135,745,644	6,770,700	536,061	13,705,286	11,620,196	32,096,182	167,841,826
221	REACTOR SYSTEM	144,169,912	75,900	1,870,086	0	146,039,998	0	0	0	0	0	146,039,998
222	VESSEL SYSTEM	155,338,141	177,012	4,338,564	337,552	160,014,257	0	0	0	0	0	160,014,257
223	HEAT TRANSPORT SYSTEM	198,884,758	22,497	591,176	8,800	199,484,734	0	0	0	0	0	199,484,734
224	SHUTDOWN COOLING SYSTEM	16,457,353	28,288	723,543	41,680	17,222,576	0	0	0	0	0	17,222,576
225	SHUTDOWN COOLING WATER SYSTEM	2,705,734	41,711	1,042,333	1,279,120	5,027,187	0	0	0	0	0	5,027,187
226	REACTOR CAVITY COOLING SYSTEM	10,571,500	106,188	2,883,310	3,680,680	17,135,490	0	0	0	0	0	17,135,490
227	REACTOR SERVICE SYSTEM	49,106,300	240,839	6,027,724	2,169,419	57,303,443	5,855,700	28,020	702,955	653,159	7,211,814	64,515,257
228	REACTOR CONTROL, PROTECTION & MONITORING	10,052,053	125,373	3,342,014	1,216,480	14,610,547	187,000	3,735	91,545	0	278,545	14,889,092
229	REACTOR PLANT MISCELLANEOUS	13,272,000	10,000	245,100	500,000	14,017,100	0	0	0	0	0	14,017,100
22	REACTOR PLANT EQUIPMENT	600,557,751	829,606	21,063,850	9,233,731	630,855,332	6,042,700	31,755	794,500	653,159	7,490,359	638,345,691
231	TURBINE GENERATOR & AUXILIARIES	96,622,906	0	0	0	96,622,906	291,500	172,857	4,222,612	354,410	4,868,522	101,491,428
233	MAIN & AUXILIARY STEAM SYSTEM	0	0	0	0	0	7,851,614	111,201	2,780,750	832,356	11,464,720	11,464,720
234	FEEDWATER & CONDENSATE SYSTEM	0	0	0	0	0	148,846,651	257,059	6,419,201	7,670,400	162,936,252	162,936,252
235	STARTUP & SHUTDOWN SYSTEM	0	0	0	0	0	0	0	0	0	0	0
236	TURBINE PLANT SAMPLING SYSTEM	0	0	0	0	0	0	0	0	0	0	0
237	ECA CONTROL, DATA & INSTRUMENTATION	0	5,480	145,822	44,000	189,822	22,960,000	124,143	3,303,445	0	26,163,445	26,353,267
23	TURBINE PLANT EQUIPMENT	96,622,906	5,480	145,822	44,000	96,812,728	179,949,765	665,260	16,726,008	8,857,166	205,432,939	302,245,667
241	SWITCHGEAR	0	13,735	370,158	0	370,158	6,355,100	23,430	631,439	0	6,986,539	7,356,697
242	STATION SERVICE EQUIPMENT	6,106,600	39,048	1,052,342	24,544	7,185,486	6,148,660	22,670	602,396	47,580	6,798,936	13,984,422
243	SWITCHBOARDS	0	834	22,476	0	22,476	3,987,200	3,512	94,648	0	4,081,848	4,104,324
244	PROTECTIVE EQUIPMENT	0	0	0	0	0	139,000	26,590	716,601	220,000	1,075,601	1,075,601
245	ELECTRIC STRUCTURES & WIRING CONTAINERS	0	467,588	12,601,496	0	12,601,496	0	49,971	1,346,718	990,320	2,337,038	14,938,534
246	POWER AND CONTROL WIRING	0	291,875	7,866,031	0	7,866,031	0	83,569	2,252,184	4,343,792	6,595,976	14,462,007
24	ELECTRIC PLANT EQUIPMENT	6,106,600	813,080	21,912,503	24,544	28,045,647	16,630,260	209,742	5,643,986	5,601,692	27,875,938	55,921,585

TABLE C–6
MHTGR–GT/IC PROTOTYPE PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
251	TRANSPORTATION AND LIFT EQUIPMENT	1,521,000	11,392	279,218	36,000	1,836,218	543,000	3,406	83,481	10,738	637,219	2,473,437
252	AIR, WATER, AND STEAM SERVICE SYSTEM	1,646,840	300,917	7,510,348	2,291,811	11,448,999	8,700,850	337,134	8,279,829	3,532,726	20,513,405	31,962,404
253	COMMUNICATIONS AND SECURITY EQUIPMENT	0	11,214	298,405	2,070,940	2,369,345	1,043,000	45,366	1,222,614	0	2,265,614	4,634,959
254	FURNISHINGS AND FIXTURES	196,000	1,968	52,505	1,112,850	1,363,355	454,500	3,501	85,810	0	540,310	1,903,665
25	MISCELLANEOUS PLANT EQUIPMENT	3,365,840	325,491	8,140,476	5,511,601	17,017,917	10,741,350	389,407	9,671,734	3,543,464	23,956,548	40,974,465
261	CIRCULATING AND SERVICE WATER PUMPHOUSE	0	0	0	0	0	3,600	12,762	307,573	198,768	509,941	509,941
262	ECA COOLING WATER SYSTEMS	0	0	0	0	0	1,283,600	65,339	1,645,439	798,100	3,727,139	3,727,139
263	CIRCULATING AND SERVICE WATER SYSTEM	0	0	0	0	0	6,646,000	262,287	6,471,747	4,572,474	17,690,221	17,690,221
26	HEAT REJECTION SYSTEM	0	0	0	0	0	7,933,200	340,388	8,424,759	5,569,342	21,927,301	21,927,301
2	TOTAL DIRECT COSTS	718,923,097	4,927,455	122,735,592	66,818,579	908,477,268	227,967,975	2,172,633	54,966,273	37,845,019	320,779,267	1,229,256,535
911	TEMPORARY CONSTRUCTION FACILITIES	0	0	41,970,367	9,940,350	51,910,718	0	0	0	7,380,000	7,380,000	59,290,718
912	CONSTRUCTION TOOLS AND EQUIPMENT	0	0	4,417,633	22,089,967	26,507,600	0	0	0	9,700,000	9,700,000	36,207,600
913	PAYROLL INSURANCE AND TAXES	0	0	30,925,534	0	30,925,534	0	0	0	20,000,000	20,000,000	50,925,534
914	PERMITS, INSURANCE, AND LOCAL TAXES	0	0	0	1,104,483	1,104,483	0	0	0	960,000	960,000	2,064,483
91	CONSTRUCTION SERVICES	0	0	77,313,535	33,134,501	110,448,335	0	0	0	38,040,000	38,040,000	148,488,335
920	REACTOR MODULE ENGINEERING AND SERVICES	52,719,324	0	0	0	52,719,324	0	0	0	0	0	52,719,324
921	PLANT ENGINEERING AND SERVICES	0	0	90,289,238	0	90,289,238	0	0	10,000,000	2,600,000	12,600,000	102,889,238
922	HOME OFFICE QUALITY ASSURANCE	0	0	1,676,308	0	1,676,308	0	0	0	0	0	1,676,308
923	HOME OFFICE PROJECT & CONSTRUCTION MGMT.	0	0	15,066,771	0	15,066,771	0	0	5,500,000	1,370,000	6,870,000	21,956,771
92	ENGINEERING AND HOME OFFICE SERVICES	52,719,324	0	107,052,317	0	159,771,641	0	0	15,500,000	3,970,000	19,470,000	179,241,641
931	FIELD OFFICE EXPENSES	0	0	2,796,551	3,728,735	6,525,286	0	0	0	900,000	900,000	7,425,286
932	FIELD JOB SUPERVISION	0	0	25,635,053	0	25,635,053	0	0	0	19,300,000	19,300,000	44,935,053
933	FIELD QUALITY ASSURANCE/QUALITY CONTROL	0	0	2,330,459	0	2,330,459	0	0	0	0	0	2,330,459
934	PLANT STARTUP AND TEST	0	0	8,389,654	3,728,735	12,118,389	0	0	0	225,000	225,000	12,343,389
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	39,151,718	7,457,470	46,609,188	0	0	0	20,425,000	20,425,000	67,034,188
941	PROJECT MANAGEMENT EXPENSES	0	0	0	0	0	0	0	21,969,402	0	21,969,402	21,969,402
942	FEES, TAXES, AND INSURANCE	0	0	0	0	0	0	0	0	60,150,000	60,150,000	60,150,000
943	SPARE PARTS AND CAPITAL EQUIPMENT	0	0	0	0	0	0	0	0	40,077,350	40,077,350	40,077,350
944	STAFF TRAINING AND STARTUP	0	0	0	0	0	0	0	48,822,525	8,460,838	57,283,363	57,283,363
945	GENERAL & ADMINISTRATIVE	0	0	0	0	0	0	0	10,618,789	7,280,728	17,899,517	17,899,517
94	OWNER'S COSTS	0	0	0	0	0	0	0	81,410,715	115,968,917	197,379,632	197,379,632
9	TOTAL INDIRECT COSTS	52,719,324	0	223,517,869	40,591,971	316,829,164	0	0	96,910,715	178,403,917	275,314,632	592,143,796
	TOTAL BASE CONSTRUCTION COST	771,642,421	4,927,455	346,253,461	107,410,550	1,225,306,432	227,967,975	2,172,633	151,876,988	216,248,936	596,093,899	1,821,400,331

TABLE C–7
MHTGR–GT/IC REPLICA PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
211	YARDWORK	0	105,679	2,462,108	1,365,975	3,828,083	756,000	68,043	1,674,127	578,686	3,008,813	6,836,896
212	REACTOR COMPLEX	12,268,000	2,631,430	63,726,968	49,701,042	125,696,010	0	0	0	0	0	125,696,010
213	TURBINE COMPLEX	0	0	0	0	0	3,349,200	330,322	8,531,951	10,271,010	22,152,161	22,152,161
214	OPERATIONS CENTER	0	0	0	0	0	2,145,000	70,074	1,820,454	445,890	4,411,344	4,411,344
215	REMOTE SHUTDOWN BUILDING	0	3,550	88,068	59,877	147,965	0	0	0	0	0	147,965
216	OTHER BUILDINGS	0	26,096	679,488	877,809	1,557,297	520,500	40,976	991,284	324,610	1,836,394	3,393,691
21	STRUCTURES & IMPROVEMENTS	12,268,000	2,766,757	66,956,652	52,004,703	131,229,355	6,770,700	509,415	13,017,816	11,620,196	31,408,712	162,638,067
221	REACTOR SYSTEM	123,572,695	70,340	1,733,160	0	125,305,855	0	0	0	0	0	125,305,855
222	VESSEL SYSTEM	144,965,614	163,834	4,015,574	337,552	149,318,740	0	0	0	0	0	149,318,740
223	HEAT TRANSPORT SYSTEM	173,408,947	20,928	549,938	8,800	173,967,685	0	0	0	0	0	173,967,685
224	SHUTDOWN COOLING SYSTEM	13,906,456	26,258	671,658	41,680	14,619,796	0	0	0	0	0	14,619,796
225	SHUTDOWN COOLING WATER SYSTEM	2,440,434	38,606	964,742	1,279,120	4,684,296	0	0	0	0	0	4,684,296
226	REACTOR CAVITY COOLING SYSTEM	9,151,626	100,133	2,668,638	3,680,680	15,500,944	0	0	0	0	0	15,500,944
227	REACTOR SERVICE SYSTEM	43,646,860	227,600	5,695,692	2,169,419	51,511,971	5,855,700	26,821	672,845	653,159	7,181,704	58,693,675
228	REACTOR CONTROL, PROTECTION & MONITORING	8,843,183	116,649	3,109,436	1,216,480	13,169,099	187,000	3,660	89,707	0	276,707	13,445,806
229	REACTOR PLANT MISCELLANEOUS	10,551,800	9,800	240,198	500,000	11,291,998	0	0	0	0	0	11,291,998
22	REACTOR PLANT EQUIPMENT	530,467,616	774,148	19,649,036	9,233,731	559,370,383	6,042,700	30,481	762,552	653,159	7,458,411	566,828,794
231	TURBINE GENERATOR & AUXILIARIES	90,256,560	0	0	0	90,256,560	291,500	160,457	3,919,994	354,410	4,565,904	94,822,464
233	MAIN & AUXILIARY STEAM SYSTEM	0	0	0	0	0	7,851,614	102,932	2,573,963	832,356	11,257,933	11,257,933
234	FEEDWATER & CONDENSATE SYSTEM	0	0	0	0	0	135,808,165	237,924	5,941,367	7,670,400	149,419,932	149,419,932
235	STARTUP & SHUTDOWN SYSTEM	0	0	0	0	0	0	0	0	0	0	0
236	TURBINE PLANT SAMPLING SYSTEM	0	0	0	0	0	0	0	0	0	0	0
237	ECA CONTROL, DATA & INSTRUMENTATION	0	5,370	142,896	44,000	186,896	22,860,000	114,901	3,057,516	0	25,917,516	26,104,412
23	TURBINE PLANT EQUIPMENT	90,256,560	5,370	142,896	44,000	90,443,456	166,811,279	616,214	15,492,840	8,857,166	191,161,285	281,604,741
241	SWITCHGEAR	0	12,713	342,615	0	342,615	6,355,100	21,702	584,870	0	6,939,970	7,282,585
242	STATION SERVICE EQUIPMENT	6,108,600	36,143	974,054	24,544	7,107,198	6,148,980	21,516	571,471	47,560	6,768,011	13,875,209
243	SWITCHBOARDS	0	773	20,834	0	20,834	3,967,200	3,250	87,589	0	4,074,789	4,095,623
244	PROTECTIVE EQUIPMENT	0	0	0	0	0	139,000	24,854	669,815	220,000	1,028,815	1,028,815
245	ELECTRIC STRUCTURES & WIRING CONTAINERS	0	432,779	11,663,393	0	11,663,393	0	46,251	1,246,465	990,320	2,236,785	13,900,178
246	POWER AND CONTROL WIRING	0	270,147	7,280,463	0	7,280,463	0	77,349	2,084,556	4,343,792	6,428,348	13,708,811
24	ELECTRIC PLANT EQUIPMENT	6,108,600	752,555	20,281,359	24,544	26,414,503	16,630,260	194,922	5,244,766	5,601,692	27,476,718	53,891,221

TABLE C–7
MHTGR–GT/IC REPLICA PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
251	TRANSPORTATION AND LIFT EQUIPMENT	1,521,000	10,840	265,689	36,000	1,822,689	543,000	3,337	81,790	10,738	635,528	2,458,217
252	AIR, WATER, AND STEAM SERVICE SYSTEM	1,640,980	292,656	7,304,809	2,291,811	11,237,580	8,700,850	328,030	8,055,180	3,532,726	20,288,756	31,526,336
253	COMMUNICATIONS AND SECURITY EQUIPMENT	0	10,991	292,470	2,070,940	2,363,410	1,043,000	43,834	1,181,326	0	2,224,326	4,587,736
254	FURNISHINGS AND FIXTURES	196,000	1,928	51,441	1,112,850	1,362,291	454,500	3,432	84,120	0	538,620	1,900,911
25	MISCELLANEOUS PLANT EQUIPMENT	3,359,980	316,415	7,914,409	5,511,601	16,785,970	10,741,350	378,633	9,402,416	3,543,464	23,687,230	40,473,200
261	CIRCULATING AND SERVICE WATER PUMPHOUSE	0	0	0	0	0	3,600	11,811	284,648	198,768	487,016	487,016
262	ECA COOLING WATER SYSTEMS	0	0	0	0	0	1,283,600	60,475	1,522,951	798,100	3,604,651	3,604,651
263	CIRCULATING AND SERVICE WATER SYSTEM	0	0	0	0	0	6,646,000	242,972	5,995,166	4,572,474	17,213,640	17,213,640
26	HEAT REJECTION SYSTEM	0	0	0	0	0	7,933,200	315,258	7,802,765	5,569,342	21,305,307	21,305,307
2	TOTAL DIRECT COSTS	642,480,736	4,615,245	114,944,352	66,818,579	824,243,667	214,929,489	2,044,923	51,723,155	37,845,019	304,497,663	1,128,741,330
911	TEMPORARY CONSTRUCTION FACILITIES	0	0	33,283,623	7,882,963	41,166,587	0	0	0	7,380,000	7,380,000	48,546,587
912	CONSTRUCTION TOOLS AND EQUIPMENT	0	0	3,503,839	17,517,997	21,021,236	0	0	0	9,700,000	9,700,000	30,721,236
913	PAYROLL INSURANCE AND TAXES	0	0	24,524,775	0	24,524,775	0	0	0	20,000,000	20,000,000	44,524,775
914	PERMITS, INSURANCE, AND LOCAL TAXES	0	0	0	875,885	875,885	0	0	0	960,000	960,000	1,835,885
91	CONSTRUCTION SERVICES	0	0	61,311,938	26,276,545	87,588,483	0	0	0	38,040,000	38,040,000	125,628,483
920	REACTOR MODULE ENGINEERING AND SERVICES	30,098,323	0	0	0	30,098,323	0	0	0	0	0	30,098,323
921	PLANT ENGINEERING AND SERVICES	0	0	30,403,849	0	30,403,849	0	0	0	2,600,000	2,600,000	33,003,849
922	HOME OFFICE QUALITY ASSURANCE	0	0	1,013,455	0	1,013,455	0	0	0	0	0	1,013,455
923	HOME OFFICE PROJECT & CONSTRUCTION MGMT.	0	0	9,121,095	0	9,121,095	0	0	0	1,370,000	1,370,000	10,491,095
92	ENGINEERING AND HOME OFFICE SERVICES	30,098,323	0	40,538,199	0	70,636,521	0	0	0	3,970,000	3,970,000	74,606,521
931	FIELD OFFICE EXPENSES	0	0	2,442,677	3,256,903	5,699,580	0	0	0	900,000	900,000	6,599,580
932	FIELD JOB SUPERVISION	0	0	22,391,207	0	22,391,207	0	0	0	19,300,000	19,300,000	41,691,207
933	FIELD QUALITY ASSURANCE/QUALITY CONTROL	0	0	2,035,564	0	2,035,564	0	0	0	0	0	2,035,564
934	PLANT STARTUP AND TEST	0	0	7,328,031	3,256,903	10,584,934	0	0	0	225,000	225,000	10,809,934
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	34,197,480	6,513,806	40,711,286	0	0	0	20,425,000	20,425,000	61,136,286
941	PROJECT MANAGEMENT EXPENSES	0	0	0	0	0	0	0	9,672,650	0	9,672,650	9,672,650
942	FEES, TAXES, AND INSURANCE	0	0	0	0	0	0	0	0	68,550,000	68,550,000	68,550,000
943	SPARE PARTS AND CAPITAL EQUIPMENT	0	0	0	0	0	0	0	0	38,583,758	38,583,758	38,583,758
944	STAFF TRAINING AND STARTUP	0	0	0	0	0	0	0	40,170,200	7,579,851	47,750,051	47,750,051
945	GENERAL & ADMINISTRATIVE	0	0	0	0	0	0	0	7,476,427	6,924,541	14,400,969	14,400,969
94	OWNER'S COSTS	0	0	0	0	0	0	0	57,319,277	121,638,150	178,957,427	178,957,427
9	TOTAL INDIRECT COSTS	30,098,323	0	136,047,616	32,790,350	196,936,290	0	0	57,319,277	184,073,150	241,392,427	440,328,717
	TOTAL BASE CONSTRUCTION COST	672,579,058	4,615,245	250,991,968	99,608,929	1,023,179,956	214,929,489	2,044,923	109,042,432	221,918,169	545,890,090	1,569,070,046

TABLE C-8
MHTGR-GT/IC TARGET PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
211	YARDWORK	0	102,348	2,384,505	1,365,975	3,750,480	756,000	65,897	1,821,324	378,686	2,956,010	6,706,490
212	REACTOR COMPLEX	12,268,000	2,548,499	61,718,605	49,701,042	123,687,647	0	0	0	0	0	123,687,647
213	TURBINE COMPLEX	0	0	0	0	0	3,349,200	319,914	8,263,129	10,271,010	21,883,339	21,883,339
214	OPERATIONS CENTER	0	0	0	0	0	2,145,000	67,866	1,763,091	445,890	4,353,981	4,353,981
215	REMOTE SHUTDOWN BUILDING	0	3,436	85,260	59,877	145,137	0	0	0	0	0	145,137
216	OTHER BUILDINGS	0	25,272	657,989	877,809	1,535,798	520,500	39,679	959,898	324,610	1,805,008	3,340,806
21	STRUCTURES & IMPROVEMENTS	12,268,000	2,679,555	64,846,359	52,004,703	129,119,062	6,770,700	493,356	12,807,442	11,620,196	30,998,338	160,117,400
221	REACTOR SYSTEM	110,574,402	66,123	1,678,533	0	112,252,935	0	0	0	0	0	112,252,935
222	VESSEL SYSTEM	138,775,509	158,670	3,888,998	337,552	143,002,059	0	0	0	0	0	143,002,059
223	HEAT TRANSPORT SYSTEM	157,792,007	20,270	532,648	8,800	158,333,455	0	0	0	0	0	158,333,455
224	SHUTDOWN COOLING SYSTEM	12,719,769	25,430	650,476	41,680	13,411,925	0	0	0	0	0	13,411,925
225	SHUTDOWN COOLING WATER SYSTEM	2,181,419	37,390	934,354	1,279,120	4,394,893	0	0	0	0	0	4,394,893
226	REACTOR CAVITY COOLING SYSTEM	8,180,320	96,979	2,584,579	3,680,680	14,445,579	0	0	0	0	0	14,445,579
227	REACTOR SERVICE SYSTEM	39,424,346	220,433	5,516,333	2,169,419	47,110,098	5,855,700	25,976	651,635	653,159	7,160,494	54,270,592
228	REACTOR CONTROL, PROTECTION & MONITORING	7,904,612	112,974	3,011,475	1,216,480	12,132,567	187,000	3,545	86,888	0	273,888	12,406,455
229	REACTOR PLANT MISCELLANEOUS	9,764,146	9,491	232,624	500,000	10,496,770	0	0	0	0	0	10,496,770
22	REACTOR PLANT EQUIPMENT	487,316,529	749,760	19,030,020	9,233,731	515,580,280	6,042,700	29,521	738,523	653,159	7,434,382	523,014,662
231	TURBINE GENERATOR & AUXILIARIES	83,818,850	0	0	0	83,818,850	291,500	155,400	3,796,447	354,410	4,442,357	88,261,207
233	MAIN & AUXILIARY STEAM SYSTEM	0	0	0	0	0	7,851,614	99,691	2,492,924	832,356	11,176,894	11,176,894
234	FEEDWATER & CONDENSATE SYSTEM	0	0	0	0	0	124,152,482	230,425	5,754,106	7,670,400	137,576,988	137,576,988
235	STARTUP & SHUTDOWN SYSTEM	0	0	0	0	0	0	0	0	0	0	0
236	TURBINE PLANT SAMPLING SYSTEM	0	0	0	0	0	0	0	0	0	0	0
237	ECA CONTROL, DATA & INSTRUMENTATION	0	5,202	138,425	44,000	182,425	22,860,000	111,280	2,961,160	0	25,821,160	26,003,585
23	TURBINE PLANT EQUIPMENT	83,818,850	5,202	138,425	44,000	84,001,275	155,155,596	596,796	15,004,637	8,857,166	179,017,399	263,018,674
241	SWITCHGEAR	0	12,312	331,808	0	331,808	6,355,100	21,016	566,361	0	6,921,461	7,253,269
242	STATION SERVICE EQUIPMENT	6,106,600	35,003	943,329	24,544	7,076,473	6,148,960	20,840	553,513	47,580	6,750,053	13,826,526
243	SWITCHBOARDS	0	749	20,186	0	20,186	3,967,200	3,149	84,866	0	4,072,066	4,092,252
244	PROTECTIVE EQUIPMENT	0	0	0	0	0	139,000	24,070	648,686	220,000	1,007,686	1,007,686
245	ELECTRIC STRUCTURES & WIRING CONTAINERS	0	419,139	11,295,797	0	11,295,797	0	44,793	1,207,172	990,320	2,197,492	13,493,289
246	POWER AND CONTROL WIRING	0	261,633	7,051,010	0	7,051,010	0	74,911	2,018,851	4,343,792	6,362,643	13,413,653
24	ELECTRIC PLANT EQUIPMENT	6,106,600	728,836	19,642,130	24,544	25,775,274	16,630,260	188,779	5,079,469	5,601,692	27,311,421	53,086,695

TABLE C–8
MHTGR–GT/IC TARGET PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
251	TRANSPORTATION AND LIFT EQUIPMENT	1,521,000	10,501	257,360	36,000	1,814,360	543,000	3,232	79,216	10,738	632,954	2,447,334
252	AIR, WATER, AND STEAM SERVICE SYSTEM	1,632,354	283,432	7,074,579	2,291,811	10,998,744	8,700,850	317,686	7,801,166	3,532,726	20,034,742	31,033,486
253	COMMUNICATIONS AND SECURITY EQUIPMENT	0	10,644	283,238	2,070,940	2,354,178	1,043,000	42,452	1,144,082	0	2,187,082	4,541,260
254	FURNISHINGS AND FIXTURES	198,000	1,870	49,863	1,112,850	1,360,743	454,500	3,322	81,424	0	535,924	1,896,667
25	MISCELLANEOUS PLANT EQUIPMENT	3,351,354	306,447	7,665,090	5,511,601	16,528,045	10,741,350	366,692	9,105,888	3,543,464	23,390,702	39,918,747
261	CIRCULATING AND SERVICE WATER PUMPHOUSE	0	0	0	0	0	3,600	11,440	275,712	198,768	478,080	478,080
262	ECA COOLING WATER SYSTEMS	0	0	0	0	0	1,283,600	58,569	1,474,952	798,100	3,556,652	3,556,652
263	CIRCULATING AND SERVICE WATER SYSTEM	0	0	0	0	0	6,646,000	235,315	5,806,222	4,572,474	17,024,696	17,024,696
26	HEAT REJECTION SYSTEM	0	0	0	0	0	7,933,200	305,324	7,556,886	5,569,342	21,059,428	21,059,428
2	TOTAL DIRECT COSTS	592,863,333	4,469,800	111,322,024	66,818,579	771,003,936	203,273,806	1,960,468	50,092,845	37,845,019	291,211,670	1,062,215,606
911	TEMPORARY CONSTRUCTION FACILITIES	0	0	32,430,203	7,680,838	40,111,040	0	0	0	7,380,000	7,380,000	47,491,040
912	CONSTRUCTION TOOLS AND EQUIPMENT	0	0	3,413,706	17,068,528	20,482,233	0	0	0	9,700,000	9,700,000	30,182,233
913	PAYROLL INSURANCE AND TAXES	0	0	23,895,939	0	23,895,939	0	0	0	20,000,000	20,000,000	43,895,939
914	PERMITS, INSURANCE, AND LOCAL TAXES	0	0	0	853,426	853,426	0	0	0	960,000	960,000	1,813,426
91	CONSTRUCTION SERVICES	0	0	59,739,847	25,602,792	85,342,639	0	0	0	38,040,000	38,040,000	123,382,639
920	REACTOR MODULE ENGINEERING AND SERVICES	18,267,117	0	0	0	18,267,117	0	0	0	0	0	18,267,117
921	PLANT ENGINEERING AND SERVICES	0	0	30,195,459	0	30,195,459	0	0	0	2,600,000	2,600,000	32,795,459
922	HOME OFFICE QUALITY ASSURANCE	0	0	1,006,515	0	1,006,515	0	0	0	0	0	1,006,515
923	HOME OFFICE PROJECT & CONSTRUCTION MGMT.	0	0	9,058,638	0	9,058,638	0	0	0	1,370,000	1,370,000	10,428,638
92	ENGINEERING AND HOME OFFICE SERVICES	18,267,117	0	40,260,613	0	58,527,730	0	0	0	3,970,000	3,970,000	62,497,730
931	FIELD OFFICE EXPENSES	0	0	2,370,955	3,161,273	5,532,228	0	0	0	900,000	900,000	6,432,228
932	FIELD JOB SUPERVISION	0	0	21,733,755	0	21,733,755	0	0	0	19,300,000	19,300,000	41,033,755
933	FIELD QUALITY ASSURANCE/QUALITY CONTROL	0	0	1,975,796	0	1,975,796	0	0	0	0	0	1,975,796
934	PLANT STARTUP AND TEST	0	0	7,112,865	3,161,273	10,274,139	0	0	0	225,000	225,000	10,499,139
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	33,193,371	6,322,547	39,515,917	0	0	0	20,425,000	20,425,000	59,940,917
941	PROJECT MANAGEMENT EXPENSES	0	0	0	0	0	0	0	7,917,168	0	7,917,168	7,917,168
942	FEES, TAXES, AND INSURANCE	0	0	0	0	0	0	0	0	59,760,000	59,760,000	59,760,000
943	SPARE PARTS AND CAPITAL EQUIPMENT	0	0	0	0	0	0	0	0	37,303,759	37,303,759	37,303,759
944	STAFF TRAINING AND STARTUP	0	0	0	0	0	0	0	25,476,948	5,287,876	30,764,824	30,764,824
945	GENERAL & ADMINISTRATIVE	0	0	0	0	0	0	0	5,009,117	6,388,745	11,397,863	11,397,863
94	OWNER'S COSTS	0	0	0	0	0	0	0	38,403,233	108,740,380	147,143,613	147,143,613
9	TOTAL INDIRECT COSTS	18,267,117	0	133,193,831	31,925,339	183,386,286	0	0	38,403,233	171,175,380	209,578,613	392,964,899
	TOTAL BASE CONSTRUCTION COST	611,130,450	4,469,800	244,515,855	98,743,918	954,390,222	203,273,806	1,960,468	88,496,078	209,020,399	500,790,283	1,455,180,505

TABLE C-9
MHTGR-GT/DC LEAD MODULE BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
211	YARDWORK	0	109,645	2,552,703	1,365,975	3,918,678	0	19,660	452,193	162,500	614,693	4,533,371
212	REACTOR COMPLEX	3,755,500	1,102,474	26,846,181	20,038,317	50,639,998	0	0	0	0	0	50,639,998
213	TURBINE COMPLEX	0	0	0	0	0	851,236	49,225	1,258,257	336,695	2,446,188	2,446,188
214	OPERATIONS CENTER	0	0	0	0	0	2,295,000	72,411	1,884,382	256,375	4,435,757	4,435,757
215	REMOTE SHUTDOWN BUILDING	0	3,622	89,873	59,877	149,750	0	0	0	0	0	149,750
216	OTHER BUILDINGS	0	26,628	693,295	877,809	1,571,104	954,313	22,559	600,488	3,795	1,558,596	3,129,700
21	STRUCTURES & IMPROVEMENTS	3,755,500	1,242,369	30,182,052	22,341,978	56,279,530	4,100,549	163,855	4,195,320	759,365	9,055,234	65,334,764
221	REACTOR SYSTEM	52,048,000	22,988	567,221	0	52,615,221	0	0	0	0	0	52,615,221
222	VESSEL SYSTEM	44,339,750	51,232	1,255,696	85,660	45,681,106	0	0	0	0	0	45,681,106
223	HEAT TRANSPORT SYSTEM	35,080,000	20,754	528,904	23,550	35,632,454	0	0	0	0	0	35,632,454
224	SHUTDOWN COOLING SYSTEM	5,711,000	9,132	234,057	10,720	5,955,777	0	0	0	0	0	5,955,777
225	SHUTDOWN COOLING WATER SYSTEM	740,000	8,447	210,977	216,080	1,167,057	0	0	0	0	0	1,167,057
226	REACTOR CAVITY COOLING SYSTEM	3,200,000	31,049	827,481	920,170	4,947,651	0	0	0	0	0	4,947,651
227	REACTOR SERVICE SYSTEM	40,376,400	146,444	3,655,678	1,031,324	45,063,402	779,700	20,030	499,966	128,500	1,408,166	46,471,568
228	REACTOR CONTROL, PROTECTION & MONITORING	7,819,000	44,019	1,173,024	925,120	9,917,144	187,000	3,735	99,388	0	286,388	10,203,532
229	REACTOR PLANT MISCELLANEOUS	11,682,000	10,000	245,100	500,000	12,427,100	0	0	0	0	0	12,427,100
22	REACTOR PLANT EQUIPMENT	200,996,150	344,065	8,698,138	3,712,624	213,406,912	966,700	23,765	599,354	128,500	1,694,554	215,101,466
231	TURBINE GENERATOR & AUXILIARIES	39,450,000	0	0	0	39,450,000	0	0	0	0	0	39,450,000
233	MAIN & AUXILIARY STEAM SYSTEM	0	0	0	0	0	145,000	3,428	85,514	30,280	260,794	260,794
234	FEEDWATER & CONDENSATE SYSTEM	0	0	0	0	0	0	0	0	0	0	0
235	STARTUP & SHUTDOWN SYSTEM	0	0	0	0	0	0	0	0	0	0	0
236	TURBINE PLANT SAMPLING SYSTEM	0	0	0	0	0	0	0	0	0	0	0
237	ECA CONTROL, DATA & INSTRUMENTATION	862,000	5,480	145,822	44,000	1,051,822	2,000,000	5,055	134,514	16,500	2,151,014	3,202,836
23	TURBINE PLANT EQUIPMENT	40,312,000	5,480	145,822	44,000	40,501,822	2,145,000	8,483	220,028	46,780	2,411,808	42,913,630
241	SWITCHGEAR	0	3,950	106,453	0	106,453	1,854,400	7,800	210,211	0	2,064,611	2,171,064
242	STATION SERVICE EQUIPMENT	1,527,150	11,229	302,621	6,136	1,835,907	2,886,400	13,225	349,029	8,400	3,243,829	5,079,736
243	SWITCHBOARDS	0	240	6,468	0	6,468	3,575,200	4,120	111,034	0	3,686,234	3,692,702
244	PROTECTIVE EQUIPMENT	0	0	0	0	0	128,700	7,705	207,651	0	336,351	336,351
245	ELECTRIC STRUCTURES & WIRING CONTAINERS	0	129,040	3,477,629	0	3,477,629	170,350	9,845	265,323	0	435,673	3,913,302
246	POWER AND CONTROL WIRING	0	83,035	2,237,794	951,150	3,188,944	922,250	22,239	599,343	0	1,521,593	4,710,537
24	ELECTRIC PLANT EQUIPMENT	1,527,150	227,494	6,130,965	957,286	8,615,401	9,537,300	64,934	1,742,591	8,400	11,288,291	19,903,692

TABLE C-9
MHTGR-GT/DC LEAD MODULE BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
251	TRANSPORTATION AND LIFT EQUIPMENT	965,500	7,180	175,982	9,000	1,150,482	352,000	1,980	48,530	0	400,530	1,551,012
252	AIR, WATER, AND STEAM SERVICE SYSTEM	810,300	272,434	6,807,566	1,162,483	8,780,349	3,832,900	168,477	4,077,520	2,588,285	10,498,705	19,279,054
253	COMMUNICATIONS AND SECURITY EQUIPMENT	0	11,214	298,405	2,070,940	2,369,345	0	34,521	930,341	935,000	1,865,341	4,234,686
254	FURNISHINGS AND FIXTURES	198,000	1,968	52,505	1,112,850	1,363,355	429,000	3,501	86,320	25,500	540,820	1,904,175
25	MISCELLANEOUS PLANT EQUIPMENT	1,973,800	292,796	7,334,458	4,355,273	13,663,531	4,613,900	208,479	5,142,711	3,548,785	13,305,396	26,968,927
261	CIRCULATING AND SERVICE WATER PUMPHOUSE	0	0	0	0	0	0	6,629	157,332	81,603	238,935	238,935
262	ECA COOLING WATER SYSTEMS	0	0	0	0	0	2,440,000	32,360	798,244	175,000	3,413,244	3,413,244
263	CIRCULATING AND SERVICE WATER SYSTEM	0	0	0	0	0	1,435,000	84,390	2,117,571	1,202,050	4,754,621	4,754,621
26	HEAT REJECTION SYSTEM	0	0	0	0	0	3,875,000	123,379	3,073,147	1,458,653	8,406,800	8,406,800
2	TOTAL DIRECT COSTS	248,564,600	2,112,204	52,491,435	31,411,161	332,467,196	25,238,449	592,895	14,973,151	7,950,483	48,162,083	380,629,279
911	TEMPORARY CONSTRUCTION FACILITIES	0	0	22,634,640	5,360,836	27,995,476	0	0	3,527,674	835,502	4,363,176	32,358,652
912	CONSTRUCTION TOOLS AND EQUIPMENT	0	0	2,382,594	11,912,969	14,295,562	0	0	371,334	1,856,671	2,228,005	16,523,567
913	PAYROLL INSURANCE AND TAXES	0	0	16,678,156	0	16,678,156	0	0	2,599,339	0	2,599,339	19,277,495
2	PERMITS, INSURANCE, AND LOCAL TAXES	0	0	0	595,648	595,648	0	0	0	92,834	92,834	688,482
91	CONSTRUCTION SERVICES	0	0	41,695,390	17,869,453	59,564,843	0	0	6,498,348	2,785,006	9,283,354	68,848,196
920	REACTOR MODULE ENGINEERING AND SERVICES	21,644,000	0	0	0	21,644,000	0	0	0	0	0	21,644,000
921	PLANT ENGINEERING AND SERVICES	0	0	71,775,364	0	71,775,364	0	0	16,151,478	0	16,151,478	87,926,842
922	HOME OFFICE QUALITY ASSURANCE	0	0	1,059,179	0	1,059,179	0	0	205,049	0	205,049	1,264,228
923	HOME OFFICE PROJECT & CONSTRUCTION MGMT.	0	0	9,532,609	0	9,532,609	0	0	7,345,443	0	7,345,443	16,878,053
92	ENGINEERING AND HOME OFFICE SERVICES	21,644,000	0	82,367,152	0	104,011,152	0	0	23,701,970	0	23,701,970	127,713,122
931	FIELD OFFICE EXPENSES	0	0	1,449,859	1,933,145	3,383,004	0	0	296,468	395,291	691,760	4,074,764
932	FIELD JOB SUPERVISION	0	0	13,290,373	0	13,290,373	0	0	2,717,627	0	2,717,627	16,008,000
933	FIELD QUALITY ASSURANCE/QUALITY CONTROL	0	0	1,208,216	0	1,208,216	0	0	247,057	0	247,057	1,455,273
934	PLANT STARTUP AND TEST	0	0	4,349,577	1,933,145	6,282,722	0	0	889,405	395,291	1,284,696	7,567,418
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	20,298,025	3,866,290	24,164,315	0	0	4,150,557	790,582	4,941,140	29,105,455
941	PROJECT MANAGEMENT EXPENSES	0	0	0	0	0	0	0	14,126,169	0	14,126,169	14,126,169
942	FEES, TAXES, AND INSURANCE	0	0	0	0	0	0	0	0	9,975,000	9,975,000	9,975,000
943	SPARE PARTS AND CAPITAL EQUIPMENT	0	0	0	0	0	0	0	0	59,170,892	59,170,892	59,170,892
944	STAFF TRAINING AND STARTUP	0	0	0	0	0	0	0	32,766,683	2,524,679	35,291,362	35,291,362
945	GENERAL & ADMINISTRATIVE	0	0	0	0	0	0	0	7,033,928	9,254,336	16,288,263	16,288,263
94	OWNER'S COSTS	0	0	0	0	0	0	0	53,926,779	80,924,908	134,851,687	134,851,687
9	TOTAL INDIRECT COSTS	21,644,000	0	144,360,567	21,735,743	187,740,310	0	0	88,277,654	84,500,496	172,778,150	360,518,460
	TOTAL BASE CONSTRUCTION COST	270,208,600	2,112,204	196,852,002	53,146,904	520,207,506	25,238,449	592,895	103,250,805	92,450,979	220,940,233	741,147,739

TABLE C–10
MHTGR–GT/DC PROTOTYPE PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
211	YARDWORK	0	109,645	2,552,703	1,365,975	3,918,678	0	19,660	452,193	162,500	614,693	4,533,371
212	REACTOR COMPLEX	12,268,000	2,544,501	61,774,541	45,948,128	119,990,669	0	0	0	0	0	119,990,669
213	TURBINE COMPLEX	0	0	0	0	0	851,236	49,225	1,258,257	336,695	2,446,188	2,446,188
214	OPERATIONS CENTER	0	0	0	0	0	2,295,000	72,411	1,884,382	256,375	4,435,757	4,435,757
215	REMOTE SHUTDOWN BUILDING	0	3,622	89,873	59,877	149,750	0	0	0	0	0	149,750
216	OTHER BUILDINGS	0	26,628	693,295	877,809	1,571,104	954,313	22,559	600,488	3,795	1,558,596	3,129,700
21	STRUCTURES & IMPROVEMENTS	12,268,000	2,684,396	65,110,412	48,251,789	125,630,201	4,100,549	163,855	4,195,320	759,365	9,055,234	134,685,435
221	REACTOR SYSTEM	144,169,912	75,900	1,870,086	0	146,039,998	0	0	0	0	0	146,039,998
222	VESSEL SYSTEM	158,414,763	181,435	4,446,972	342,640	163,204,375	0	0	0	0	0	163,204,375
223	HEAT TRANSPORT SYSTEM	118,043,907	71,675	1,827,075	93,600	119,964,582	0	0	0	0	0	119,964,582
224	SHUTDOWN COOLING SYSTEM	16,457,353	28,288	723,543	41,680	17,222,576	0	0	0	0	0	17,222,576
225	SHUTDOWN COOLING WATER SYSTEM	2,705,734	29,373	733,636	864,320	4,303,690	0	0	0	0	0	4,303,690
226	REACTOR CAVITY COOLING SYSTEM	10,571,500	108,188	2,883,310	3,680,680	17,135,490	0	0	0	0	0	17,135,490
227	REACTOR SERVICE SYSTEM	52,306,300	243,599	6,095,371	2,169,419	60,571,090	779,700	20,030	499,966	128,500	1,408,166	61,979,256
228	REACTOR CONTROL, PROTECTION & MONITORING	12,007,940	125,373	3,342,014	1,216,480	16,566,434	187,000	3,735	99,388	0	286,388	16,852,822
229	REACTOR PLANT MISCELLANEOUS	13,272,000	10,000	245,100	500,000	14,017,100	0	0	0	0	0	14,017,100
22	REACTOR PLANT EQUIPMENT	527,949,409	873,831	22,167,107	8,908,819	559,025,335	966,700	23,765	599,354	128,500	1,694,554	560,719,889
231	TURBINE GENERATOR & AUXILIARIES	145,790,716	0	0	0	145,790,716	0	0	0	0	0	145,790,716
233	MAIN & AUXILIARY STEAM SYSTEM	0	0	0	0	0	145,000	3,428	85,514	30,280	260,794	260,794
234	FEEDWATER & CONDENSATE SYSTEM	0	0	0	0	0	0	0	0	0	0	0
235	STARTUP & SHUTDOWN SYSTEM	0	0	0	0	0	0	0	0	0	0	0
236	TURBINE PLANT SAMPLING SYSTEM	0	0	0	0	0	0	0	0	0	0	0
237	ECA CONTROL, DATA & INSTRUMENTATION	2,669,383	5,480	145,822	44,000	2,859,205	2,000,000	5,055	134,514	16,500	2,151,014	5,010,219
23	TURBINE PLANT EQUIPMENT	148,460,099	5,480	145,822	44,000	148,649,921	2,145,000	8,483	220,028	46,780	2,411,808	151,061,729
241	SWITCHGEAR	0	13,735	370,158	0	370,158	5,917,600	24,647	664,237	0	6,581,837	6,951,995
242	STATION SERVICE EQUIPMENT	6,108,600	39,048	1,052,342	24,544	7,185,486	5,477,200	21,600	574,735	8,400	6,060,335	13,245,821
243	SWITCHBOARDS	0	834	22,476	0	22,476	3,575,200	4,120	111,034	0	3,686,234	3,708,710
244	PROTECTIVE EQUIPMENT	0	0	0	0	0	249,000	15,720	423,655	0	672,655	672,655
245	ELECTRIC STRUCTURES & WIRING CONTAINERS	0	448,724	12,093,111	0	12,093,111	681,400	34,235	922,633	0	1,604,033	13,697,144
246	POWER AND CONTROL WIRING	0	288,745	7,781,679	3,804,600	11,586,279	3,689,000	77,333	2,084,124	0	5,773,124	17,359,403
24	ELECTRIC PLANT EQUIPMENT	6,108,600	791,086	21,319,766	3,829,144	31,257,510	19,589,400	177,655	4,780,418	8,400	24,378,218	55,635,728

TABLE C–10
MHTGR–GT/DC PROTOTYPE PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
251	TRANSPORTATION AND LIFT EQUIPMENT	1,441,000	11,392	279,218	36,000	1,756,218	352,000	1,980	48,530	0	400,530	2,156,748
252	AIR, WATER, AND STEAM SERVICE SYSTEM	1,626,840	301,799	7,531,966	2,485,273	11,644,079	4,432,900	185,355	4,499,069	2,740,835	11,672,804	23,316,883
253	COMMUNICATIONS AND SECURITY EQUIPMENT	0	11,214	298,405	2,070,940	2,369,345	0	34,521	930,341	935,000	1,865,341	4,234,686
254	FURNISHINGS AND FIXTURES	198,000	1,968	52,505	1,112,850	1,363,355	429,000	3,501	86,320	25,500	540,820	1,904,175
25	MISCELLANEOUS PLANT EQUIPMENT	3,265,840	326,373	8,162,094	5,705,063	17,132,997	5,213,900	225,357	5,564,260	3,701,335	14,479,495	31,612,492
261	CIRCULATING AND SERVICE WATER PUMPHOUSE	0	0	0	0	0	0	11,753	278,945	163,206	442,151	442,151
262	ECA COOLING WATER SYSTEMS	0	0	0	0	0	8,020,000	60,998	1,512,795	700,000	10,232,795	10,232,795
263	CIRCULATING AND SERVICE WATER SYSTEM	0	0	0	0	0	5,140,000	288,500	7,242,127	4,808,200	17,190,327	17,190,327
26	HEAT REJECTION SYSTEM	0	0	0	0	0	13,160,000	361,251	9,033,867	5,671,406	27,865,273	27,865,273
2	TOTAL DIRECT COSTS	698,051,948	4,681,166	116,905,201	66,738,815	881,695,964	45,175,549	960,366	24,393,247	12,315,786	81,884,582	963,580,546
911	TEMPORARY CONSTRUCTION FACILITIES	0	0	41,019,814	9,715,219	50,735,033	0	0	5,747,049	1,361,143	7,108,192	57,843,225
912	CONSTRUCTION TOOLS AND EQUIPMENT	0	0	4,317,875	21,589,376	25,907,251	0	0	604,953	3,024,763	3,629,715	29,536,966
913	PAYROLL INSURANCE AND TAXES	0	0	30,225,126	0	30,225,126	0	0	4,234,668	0	4,234,668	34,459,794
2	PERMITS, INSURANCE, AND LOCAL TAXES	0	0	0	1,079,469	1,079,469	0	0	0	151,238	151,238	1,230,707
91	CONSTRUCTION SERVICES	0	0	75,562,815	32,384,064	107,946,878	0	0	10,586,669	4,537,144	15,123,813	123,070,691
920	REACTOR MODULE ENGINEERING AND SERVICES	52,719,324	0	0	0	52,719,324	0	0	0	0	0	52,719,324
921	PLANT ENGINEERING AND SERVICES	0	0	89,978,888	0	89,978,888	0	0	20,583,224	0	20,583,224	110,562,112
922	HOME OFFICE QUALITY ASSURANCE	0	0	1,665,963	0	1,665,963	0	0	352,774	0	352,774	2,018,737
923	HOME OFFICE PROJECT & CONSTRUCTION MGMT.	0	0	14,993,666	0	14,993,666	0	0	8,674,967	0	8,674,967	23,668,634
92	ENGINEERING AND HOME OFFICE SERVICES	52,719,324	0	106,638,517	0	159,357,841	0	0	29,610,965	0	29,610,965	188,968,806
931	FIELD OFFICE EXPENSES	0	0	2,716,306	3,621,741	6,338,047	0	0	482,986	643,982	1,126,968	7,465,015
932	FIELD JOB SUPERVISION	0	0	24,899,472	0	24,899,472	0	0	4,427,374	0	4,427,374	29,326,846
933	FIELD QUALITY ASSURANCE/QUALITY CONTROL	0	0	2,263,588	0	2,263,588	0	0	402,489	0	402,489	2,666,077
934	PLANT STARTUP AND TEST	0	0	8,148,918	3,621,741	11,770,659	0	0	1,448,959	643,982	2,092,941	13,863,600
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	38,028,284	7,243,483	45,271,767	0	0	6,761,808	1,287,963	8,049,772	53,321,539
941	PROJECT MANAGEMENT EXPENSES	0	0	0	0	0	0	0	22,282,796	0	22,282,796	22,282,796
942	FEES, TAXES, AND INSURANCE	0	0	0	0	0	0	0	0	55,650,000	55,650,000	55,650,000
943	SPARE PARTS AND CAPITAL EQUIPMENT	0	0	0	0	0	0	0	0	70,642,938	70,642,938	70,642,938
944	STAFF TRAINING AND STARTUP	0	0	0	0	0	0	0	45,333,032	6,145,927	51,478,959	51,478,959
945	GENERAL & ADMINISTRATIVE	0	0	0	0	0	0	0	10,142,374	11,518,330	21,660,704	21,660,704
94	OWNER'S COSTS	0	0	0	0	0	0	0	77,758,202	143,957,195	221,715,397	221,715,397
9	TOTAL INDIRECT COSTS	52,719,324	0	220,229,616	39,627,546	312,576,487	0	0	124,717,644	149,782,303	274,499,947	587,076,433
	TOTAL BASE CONSTRUCTION COST	750,771,271	4,681,166	337,134,817	106,366,361	1,194,272,450	45,175,549	960,366	149,110,891	162,098,089	356,384,529	1,550,656,979

TABLE C-11
MHTGR-GT/DC REPLICA PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
211	YARDWORK	0	107,452	2,501,646	1,365,975	3,867,621	0	19,267	443,155	162,500	605,655	4,473,276
212	REACTOR COMPLEX	12,268,000	2,380,614	57,801,180	45,948,128	116,017,308	0	0	0	0	0	116,017,308
213	TURBINE COMPLEX	0	0	0	0	0	851,236	48,243	1,233,152	336,695	2,421,083	2,421,083
214	OPERATIONS CENTER	0	0	0	0	0	2,295,000	70,964	1,846,723	256,375	4,398,098	4,398,098
215	REMOTE SHUTDOWN BUILDING	0	3,550	88,088	59,877	147,965	0	0	0	0	0	147,965
216	OTHER BUILDINGS	0	26,098	679,488	877,809	1,557,297	954,313	22,109	588,510	3,795	1,546,618	3,103,915
21	STRUCTURES & IMPROVEMENTS	12,268,000	2,517,714	61,070,402	48,251,789	121,590,191	4,100,549	160,583	4,111,540	759,365	8,971,454	130,561,645
221	REACTOR SYSTEM	123,572,695	70,340	1,733,160	0	125,305,855	0	0	0	0	0	125,305,855
222	VESSEL SYSTEM	147,784,982	167,928	4,115,918	342,640	152,243,540	0	0	0	0	0	152,243,540
223	HEAT TRANSPORT SYSTEM	103,734,729	66,349	1,691,302	93,600	105,519,631	0	0	0	0	0	105,519,631
224	SHUTDOWN COOLING SYSTEM	13,906,458	26,258	671,658	41,680	14,619,796	0	0	0	0	0	14,619,796
225	SHUTDOWN COOLING WATER SYSTEM	2,440,434	27,186	679,013	864,320	3,983,767	0	0	0	0	0	3,983,767
226	REACTOR CAVITY COOLING SYSTEM	9,151,626	100,133	2,668,638	3,680,680	15,500,944	0	0	0	0	0	15,500,944
227	REACTOR SERVICE SYSTEM	46,654,860	230,305	5,761,991	2,169,419	54,586,270	779,700	19,629	489,956	128,500	1,398,156	55,984,426
228	REACTOR CONTROL, PROTECTION & MONITORING	10,132,320	116,649	3,109,436	1,216,480	14,458,236	187,000	3,660	97,393	0	284,393	14,742,629
229	REACTOR PLANT MISCELLANEOUS	10,551,800	9,800	240,198	500,000	11,291,998	0	0	0	0	0	11,291,998
22	REACTOR PLANT EQUIPMENT	467,929,904	814,948	20,671,314	8,908,819	497,510,037	966,700	23,289	587,349	128,500	1,682,549	499,192,586
231	TURBINE GENERATOR & AUXILIARIES	132,020,685	0	0	0	132,020,685	0	0	0	0	0	132,020,685
233	MAIN & AUXILIARY STEAM SYSTEM	0	0	0	0	0	145,000	3,359	83,793	30,280	259,073	259,073
234	FEEDWATER & CONDENSATE SYSTEM	0	0	0	0	0	0	0	0	0	0	0
235	STARTUP & SHUTDOWN SYSTEM	0	0	0	0	0	0	0	0	0	0	0
236	TURBINE PLANT SAMPLING SYSTEM	0	0	0	0	0	0	0	0	0	0	0
237	ECA CONTROL, DATA & INSTRUMENTATION	2,403,643	5,370	142,896	44,000	2,590,539	2,000,000	4,954	131,826	16,500	2,148,326	4,738,865
23	TURBINE PLANT EQUIPMENT	134,424,328	5,370	142,896	44,000	134,611,224	2,145,000	8,313	215,619	46,780	2,407,399	137,018,623
241	SWITCHGEAR	0	12,713	342,615	0	342,615	5,917,600	22,866	616,239	0	6,533,839	6,876,454
242	STATION SERVICE EQUIPMENT	6,108,600	36,143	974,054	24,544	7,107,198	5,477,200	20,525	545,915	8,400	6,031,515	13,138,713
243	SWITCHBOARDS	0	773	20,834	0	20,834	3,575,200	4,038	108,825	0	3,684,025	3,704,859
244	PROTECTIVE EQUIPMENT	0	0	0	0	0	249,000	14,793	398,671	0	647,671	647,671
245	ELECTRIC STRUCTURES & WIRING CONTAINERS	0	415,319	11,192,847	0	11,192,847	681,400	31,687	853,965	0	1,535,365	12,728,212
246	POWER AND CONTROL WIRING	0	267,249	7,202,361	3,804,600	11,006,961	3,689,000	71,577	1,928,999	0	5,617,999	16,624,960
24	ELECTRIC PLANT EQUIPMENT	6,108,600	732,197	19,732,711	3,829,144	29,670,455	19,589,400	165,486	4,452,614	8,400	24,050,414	53,720,869

TABLE C-11
MHTGR-GT/DC REPLICA PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
251	TRANSPORTATION AND LIFT EQUIPMENT	1,441,000	10,840	265,689	36,000	1,742,689	352,000	1,940	47,550	0	399,550	2,142,239
252	AIR, WATER, AND STEAM SERVICE SYSTEM	1,620,960	293,521	7,326,010	2,485,273	11,432,243	4,432,900	180,360	4,376,921	2,740,835	11,550,656	22,982,899
253	COMMUNICATIONS AND SECURITY EQUIPMENT	0	10,991	292,470	2,070,940	2,363,410	0	33,831	911,745	935,000	1,846,745	4,210,155
254	FURNISHINGS AND FIXTURES	198,000	1,928	51,441	1,112,850	1,362,291	429,000	3,432	84,620	25,500	539,120	1,901,411
25	MISCELLANEOUS PLANT EQUIPMENT	3,259,960	317,280	7,935,610	5,705,063	16,900,633	5,213,900	219,563	5,420,836	3,701,335	14,336,071	31,236,704
261	CIRCULATING AND SERVICE WATER PUMPHOUSE	0	0	0	0	0	0	10,877	258,156	163,206	421,362	421,362
262	ECA COOLING WATER SYSTEMS	0	0	0	0	0	8,020,000	57,590	1,427,946	700,000	10,147,946	10,147,946
263	CIRCULATING AND SERVICE WATER SYSTEM	0	0	0	0	0	5,140,000	267,133	6,705,695	4,808,200	16,653,895	16,653,895
26	HEAT REJECTION SYSTEM	0	0	0	0	0	13,160,000	335,600	8,391,797	5,671,406	27,223,203	27,223,203
2	TOTAL DIRECT COSTS	623,990,792	4,387,509	109,552,933	66,738,815	800,282,540	45,175,549	912,834	23,179,755	12,315,786	80,671,090	880,953,630
911	TEMPORARY CONSTRUCTION FACILITIES	0	0	32,583,141	7,717,060	40,300,200	0	0	5,461,150	1,293,430	6,754,581	47,054,781
912	CONSTRUCTION TOOLS AND EQUIPMENT	0	0	3,429,804	17,149,021	20,578,826	0	0	574,858	2,874,290	3,449,148	24,027,973
913	PAYROLL INSURANCE AND TAXES	0	0	24,008,630	0	24,008,630	0	0	4,024,005	0	4,024,005	28,032,635
914	PERMITS, INSURANCE, AND LOCAL TAXES	0	0	0	857,451	857,451	0	0	0	143,714	143,714	1,001,166
91	CONSTRUCTION SERVICES	0	0	60,021,575	25,723,532	85,745,107	0	0	10,060,014	4,311,434	14,371,448	100,116,555
920	REACTOR MODULE ENGINEERING AND SERVICES	30,098,323	0	0	0	30,098,323	0	0	0	0	0	30,098,323
921	PLANT ENGINEERING AND SERVICES	0	0	30,141,688	0	30,141,688	0	0	3,022,828	0	3,022,828	33,164,516
922	HOME OFFICE QUALITY ASSURANCE	0	0	1,004,723	0	1,004,723	0	0	100,761	0	100,761	1,105,484
923	HOME OFFICE PROJECT & CONSTRUCTION MGMT.	0	0	9,042,506	0	9,042,506	0	0	906,848	0	906,848	9,949,355
92	ENGINEERING AND HOME OFFICE SERVICES	30,098,323	0	40,188,917	0	70,287,240	0	0	4,030,438	0	4,030,438	74,317,677
931	FIELD OFFICE EXPENSES	0	0	2,383,448	3,177,931	5,561,379	0	0	458,959	611,946	1,070,905	6,632,283
932	FIELD JOB SUPERVISION	0	0	21,848,274	0	21,848,274	0	0	4,207,126	0	4,207,126	26,055,399
933	FIELD QUALITY ASSURANCE/QUALITY CONTROL	0	0	1,986,207	0	1,986,207	0	0	382,466	0	382,466	2,368,673
934	PLANT STARTUP AND TEST	0	0	7,150,344	3,177,931	10,328,275	0	0	1,376,877	611,946	1,988,823	12,317,098
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	33,368,273	6,355,861	39,724,134	0	0	6,425,428	1,223,891	7,649,319	47,373,453
941	PROJECT MANAGEMENT EXPENSES	0	0	0	0	0	0	0	10,020,401	0	10,020,401	10,020,401
942	FEES, TAXES, AND INSURANCE	0	0	0	0	0	0	0	0	57,800,000	57,800,000	57,800,000
943	SPARE PARTS AND CAPITAL EQUIPMENT	0	0	0	0	0	0	0	0	65,745,684	65,745,684	65,745,684
944	STAFF TRAINING AND STARTUP	0	0	0	0	0	0	0	37,670,769	5,411,171	43,081,940	43,081,940
945	GENERAL & ADMINISTRATIVE	0	0	0	0	0	0	0	7,153,676	10,673,528	17,827,204	17,827,204
94	OWNER'S COSTS	0	0	0	0	0	0	0	54,844,846	139,630,384	194,475,229	194,475,229
9	TOTAL INDIRECT COSTS	30,098,323	0	133,578,765	32,079,394	195,756,481	0	0	75,360,725	145,165,709	220,526,434	416,282,915
	TOTAL BASE CONSTRUCTION COST	654,089,115	4,387,509	243,131,698	98,818,209	996,039,021	45,175,549	912,834	98,540,480	157,481,495	301,197,524	1,297,236,545

TABLE C-12
MHTGR-GT/DC TARGET PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
20	LAND & LAND RIGHTS	0	0	0	0	0	0	0	0	2,000,000	2,000,000	2,000,000
211	YARDWORK	0	104,065	2,422,794	1,365,975	3,788,769	0	18,658	429,144	162,500	591,644	4,380,413
212	REACTOR COMPLEX	12,268,000	2,305,585	55,979,505	45,948,128	114,195,633	0	0	0	0	0	114,195,633
213	TURBINE COMPLEX	0	0	0	0	0	851,236	46,718	1,194,180	336,695	2,382,111	2,382,111
214	OPERATIONS CENTER	0	0	0	0	0	2,295,000	68,727	1,788,510	256,375	4,339,885	4,339,885
215	REMOTE SHUTDOWN BUILDING	0	3,436	85,260	59,877	145,137	0	0	0	0	0	145,137
216	OTHER BUILDINGS	0	25,272	657,989	877,809	1,535,798	954,313	21,411	569,930	3,795	1,528,038	3,063,836
21	STRUCTURES & IMPROVEMENTS	12,268,000	2,438,358	59,145,548	48,251,789	119,665,337	4,100,549	155,514	3,981,764	759,365	8,841,678	128,507,015
221	REACTOR SYSTEM	110,574,402	68,123	1,678,533	0	112,252,935	0	0	0	0	0	112,252,935
222	VESSEL SYSTEM	141,322,240	162,635	3,986,180	342,640	145,651,060	0	0	0	0	0	145,651,060
223	HEAT TRANSPORT SYSTEM	93,790,797	64,258	1,637,995	93,600	95,522,392	0	0	0	0	0	95,522,392
224	SHUTDOWN COOLING SYSTEM	12,719,769	25,430	650,476	41,680	13,411,925	0	0	0	0	0	13,411,925
225	SHUTDOWN COOLING WATER SYSTEM	2,181,419	26,331	657,658	864,320	3,703,397	0	0	0	0	0	3,703,397
226	REACTOR CAVITY COOLING SYSTEM	8,180,320	96,979	2,584,579	3,680,680	14,445,579	0	0	0	0	0	14,445,579
227	REACTOR SERVICE SYSTEM	42,151,354	223,052	5,580,525	2,169,419	49,901,298	779,700	19,009	474,480	128,500	1,382,680	51,283,978
228	REACTOR CONTROL, PROTECTION & MONITORING	9,120,075	112,974	3,011,475	1,216,480	13,348,030	187,000	3,545	94,332	0	281,332	13,629,362
229	REACTOR PLANT MISCELLANEOUS	9,764,146	9,491	232,624	500,000	10,496,770	0	0	0	0	0	10,496,770
22	REACTOR PLANT EQUIPMENT	429,804,521	789,273	20,020,045	8,908,819	458,733,385	966,700	22,554	568,812	128,500	1,664,012	460,397,397
231	TURBINE GENERATOR & AUXILIARIES	118,008,683	0	0	0	118,008,683	0	0	0	0	0	118,008,683
233	MAIN & AUXILIARY STEAM SYSTEM	0	0	0	0	0	145,000	3,254	81,171	30,280	256,451	256,451
234	FEEDWATER & CONDENSATE SYSTEM	0	0	0	0	0	0	0	0	0	0	0
235	STARTUP & SHUTDOWN SYSTEM	0	0	0	0	0	0	0	0	0	0	0
236	TURBINE PLANT SAMPLING SYSTEM	0	0	0	0	0	0	0	0	0	0	0
237	ECA CONTROL, DATA & INSTRUMENTATION	2,150,565	5,202	138,425	44,000	2,332,990	2,000,000	4,798	127,675	16,500	2,144,175	4,477,165
23	TURBINE PLANT EQUIPMENT	120,159,249	5,202	138,425	44,000	120,341,674	2,145,000	8,052	208,846	46,780	2,400,626	122,742,300
241	SWITCHGEAR	0	12,312	331,808	0	331,808	5,917,600	22,146	596,835	0	6,514,435	6,846,243
242	STATION SERVICE EQUIPMENT	6,108,600	35,003	943,329	24,544	7,076,473	5,477,200	19,879	528,733	8,400	6,014,333	13,090,806
243	SWITCHBOARDS	0	749	20,186	0	20,186	3,575,200	3,909	105,349	0	3,680,549	3,700,735
244	PROTECTIVE EQUIPMENT	0	0	0	0	0	249,000	14,326	386,085	0	635,085	635,085
245	ELECTRIC STRUCTURES & WIRING CONTAINERS	0	402,229	10,840,072	0	10,840,072	681,400	30,688	827,042	0	1,508,442	12,348,514
246	POWER AND CONTROL WIRING	0	258,828	6,975,415	3,804,600	10,780,015	3,689,000	69,321	1,868,201	0	5,557,201	16,337,216
24	ELECTRIC PLANT EQUIPMENT	6,108,600	709,121	19,110,810	3,829,144	29,048,554	19,589,400	160,269	4,312,245	8,400	23,910,045	52,958,599

TABLE C–12
MHTGR–GT/DC TARGET PLANT BASE CONSTRUCTION COST

COST BASIS: JANUARY 1992$, EAST/WEST CENTRAL SITE		NUCLEAR ISLAND (NI)					ENERGY CONVERSION AREA (ECA)					
ACCOUNT NUMBER	ACCOUNT DESCRIPTION	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL NI	FACTORY EQUIPMENT	SITE LABOR HOURS	SITE LABOR COST	SITE MATERIAL	TOTAL ECA	TOTAL ESTIMATE
251	TRANSPORTATION AND LIFT EQUIPMENT	1,441,000	10,501	257,380	36,000	1,734,380	352,000	1,879	46,054	0	398,054	2,132,434
252	AIR, WATER, AND STEAM SERVICE SYSTEM	1,612,354	284,269	7,095,094	2,485,273	11,192,721	4,432,900	174,671	4,238,863	2,740,835	11,412,598	22,605,319
253	COMMUNICATIONS AND SECURITY EQUIPMENT	0	10,644	283,238	2,070,940	2,354,178	0	32,764	882,990	935,000	1,817,990	4,172,168
254	FURNISHINGS AND FIXTURES	198,000	1,870	49,893	1,112,850	1,360,743	429,000	3,322	81,908	25,500	536,408	1,897,151
25	MISCELLANEOUS PLANT EQUIPMENT	3,251,354	307,284	7,685,605	5,705,063	16,642,022	5,213,900	212,636	5,249,815	3,701,335	14,165,050	30,807,072
261	CIRCULATING AND SERVICE WATER PUMPHOUSE	0	0	0	0	0	0	10,535	250,037	163,206	413,243	413,243
262	ECA COOLING WATER SYSTEMS	0	0	0	0	0	8,020,000	55,775	1,382,942	700,000	10,102,942	10,102,942
263	CIRCULATING AND SERVICE WATER SYSTEM	0	0	0	0	0	5,140,000	258,718	6,494,452	4,808,200	16,442,652	16,442,652
26	HEAT REJECTION SYSTEM	0	0	0	0	0	13,160,000	325,028	8,127,431	5,671,406	26,958,837	26,958,837
2	TOTAL DIRECT COSTS	571,591,724	4,249,238	106,100,433	66,738,815	744,430,972	45,175,549	884,053	22,448,913	12,315,786	79,940,248	824,371,220
911	TEMPORARY CONSTRUCTION FACILITIES	0	0	31,751,804	7,520,164	39,271,968	0	0	5,288,964	1,252,649	6,541,613	45,813,581
912	CONSTRUCTION TOOLS AND EQUIPMENT	0	0	3,342,295	16,711,476	20,053,771	0	0	556,733	2,783,665	3,340,398	23,394,169
913	PAYROLL INSURANCE AND TAXES	0	0	23,396,066	0	23,396,066	0	0	3,897,131	0	3,897,131	27,293,197
914	PERMITS, INSURANCE, AND LOCAL TAXES	0	0	0	835,574	835,574	0	0	0	139,183	139,183	974,757
91	CONSTRUCTION SERVICES	0	0	58,490,165	25,067,213	83,557,378	0	0	9,742,828	4,175,498	13,918,326	97,475,704
920	REACTOR MODULE ENGINEERING AND SERVICES	18,267,117	0	0	0	18,267,117	0	0	0	0	0	18,267,117
921	PLANT ENGINEERING AND SERVICES	0	0	29,938,886	0	29,938,886	0	0	2,980,824	0	2,980,824	32,919,709
922	HOME OFFICE QUALITY ASSURANCE	0	0	997,963	0	997,963	0	0	99,361	0	99,361	1,097,324
923	HOME OFFICE PROJECT & CONSTRUCTION MGMT.	0	0	8,981,666	0	8,981,666	0	0	894,247	0	894,247	9,875,913
92	ENGINEERING AND HOME OFFICE SERVICES	18,267,117	0	39,918,514	0	58,185,631	0	0	3,974,432	0	3,974,432	62,160,063
931	FIELD OFFICE EXPENSES	0	0	2,313,582	3,084,776	5,398,358	0	0	444,488	592,651	1,037,140	6,435,497
932	FIELD JOB SUPERVISION	0	0	21,207,834	0	21,207,834	0	0	4,074,478	0	4,074,478	25,282,312
933	FIELD QUALITY ASSURANCE/QUALITY CONTROL	0	0	1,927,985	0	1,927,985	0	0	370,407	0	370,407	2,298,392
934	PLANT STARTUP AND TEST	0	0	6,940,746	3,084,776	10,025,521	0	0	1,333,465	592,651	1,926,117	11,951,638
93	FIELD SUPERVISION & FIELD OFFICE SERVICES	0	0	32,390,146	6,169,552	38,559,698	0	0	6,222,839	1,185,303	7,408,141	45,967,839
941	PROJECT MANAGEMENT EXPENSES	0	0	0	0	0	0	0	8,233,510	0	8,233,510	8,233,510
942	FEES, TAXES, AND INSURANCE	0	0	0	0	0	0	0	0	50,010,000	50,010,000	50,010,000
943	SPARE PARTS AND CAPITAL EQUIPMENT	0	0	0	0	0	0	0	0	59,654,256	59,654,256	59,654,256
944	STAFF TRAINING AND STARTUP	0	0	0	0	0	0	0	24,183,972	4,068,633	28,252,605	28,252,605
945	GENERAL & ADMINISTRATIVE	0	0	0	0	0	0	0	4,862,622	9,558,433	14,421,056	14,421,056
94	OWNER'S COSTS	0	0	0	0	0	0	0	37,280,104	123,291,322	160,571,427	160,571,427
9	TOTAL INDIRECT COSTS	18,267,117	0	130,798,825	31,236,765	180,302,707	0	0	57,220,203	128,652,123	185,872,326	366,175,033
	TOTAL BASE CONSTRUCTION COST	589,858,841	4,249,238	236,899,258	97,975,580	924,733,679	45,175,549	884,053	79,669,116	140,967,909	265,812,574	1,190,546,253

APPENDIX D

MHTGR PLANT CONSTRUCTION SCHEDULES

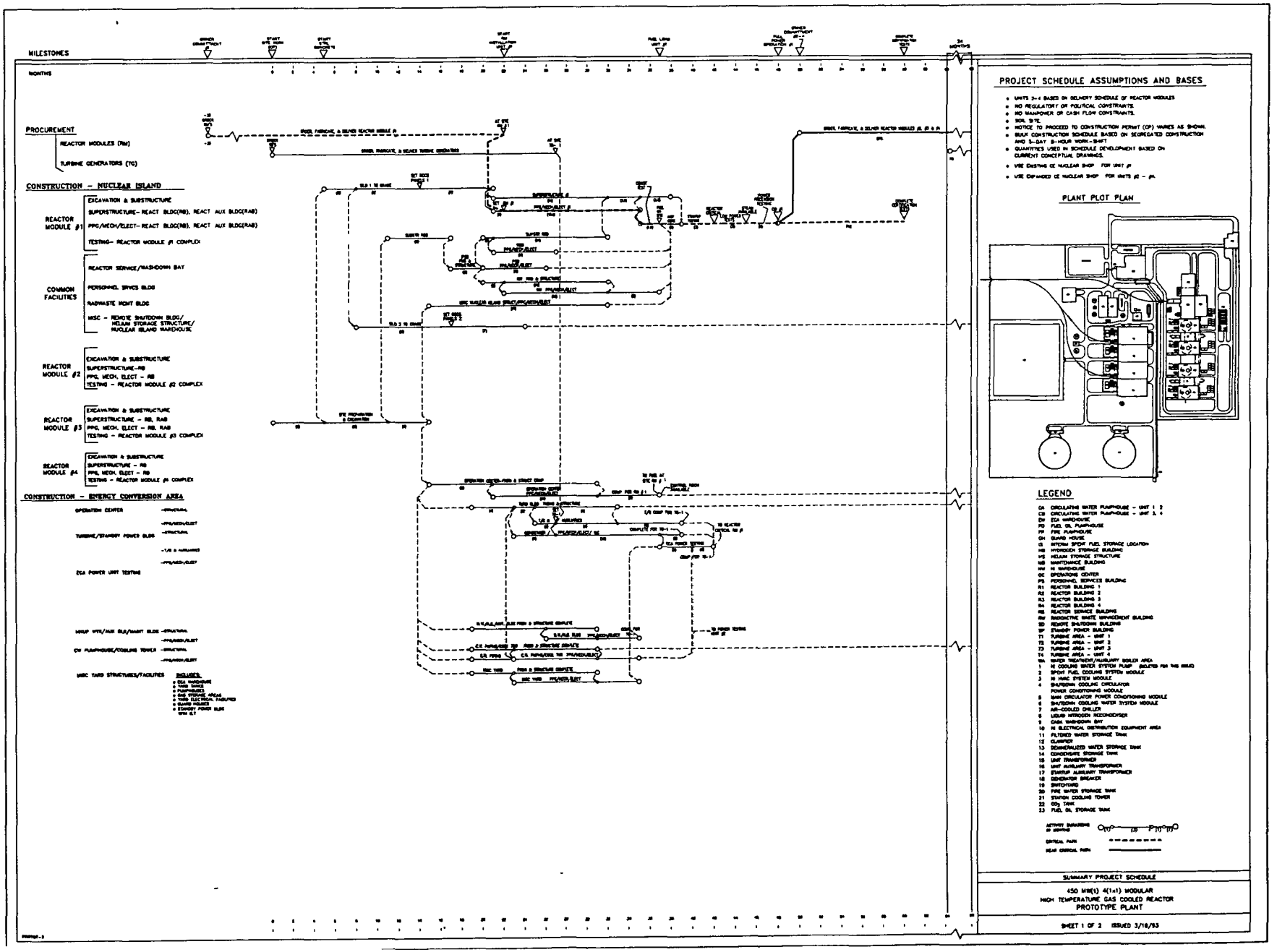
APPENDIX D

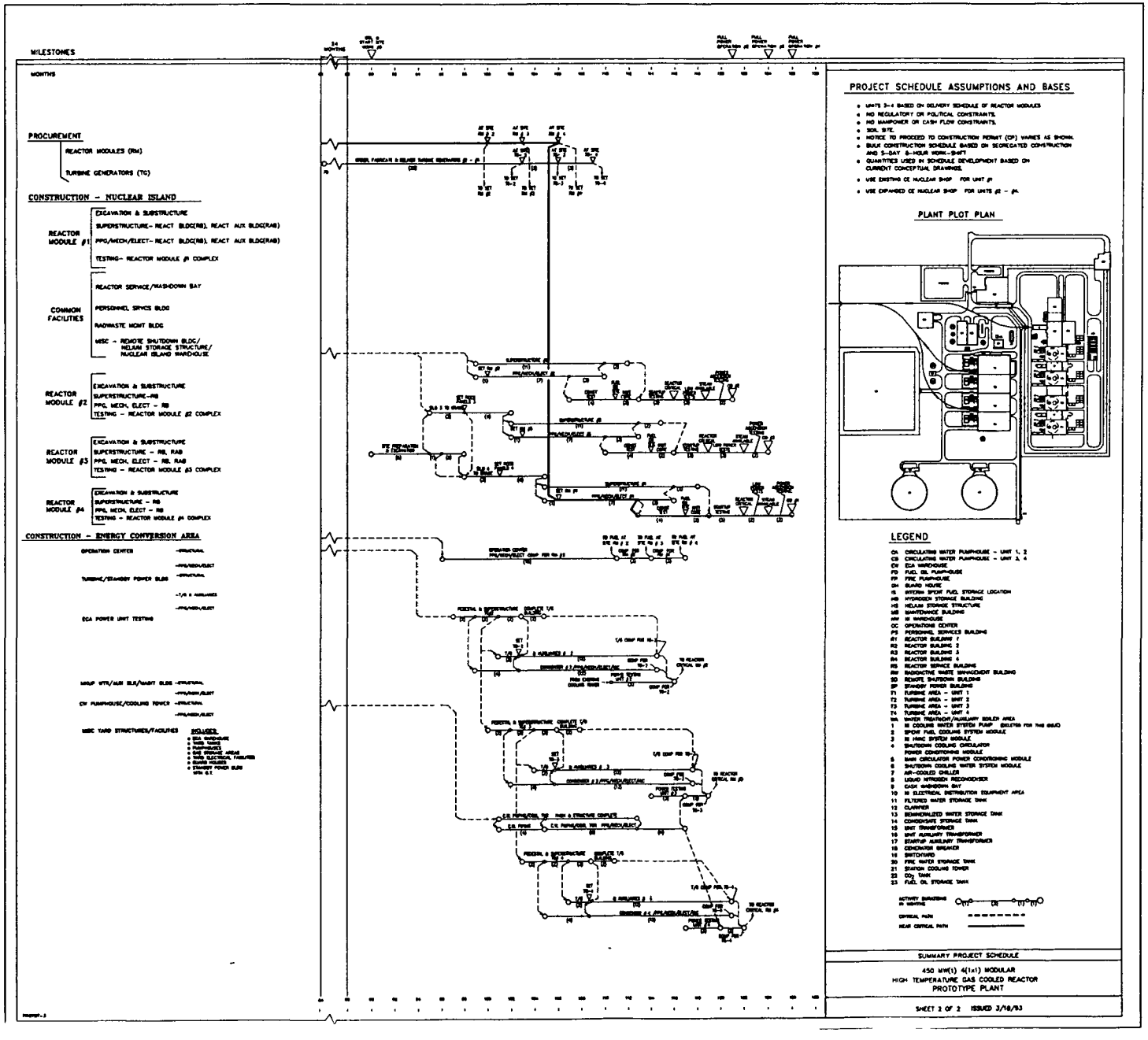
MHTGR PLANT CONSTRUCTION SCHEDULES

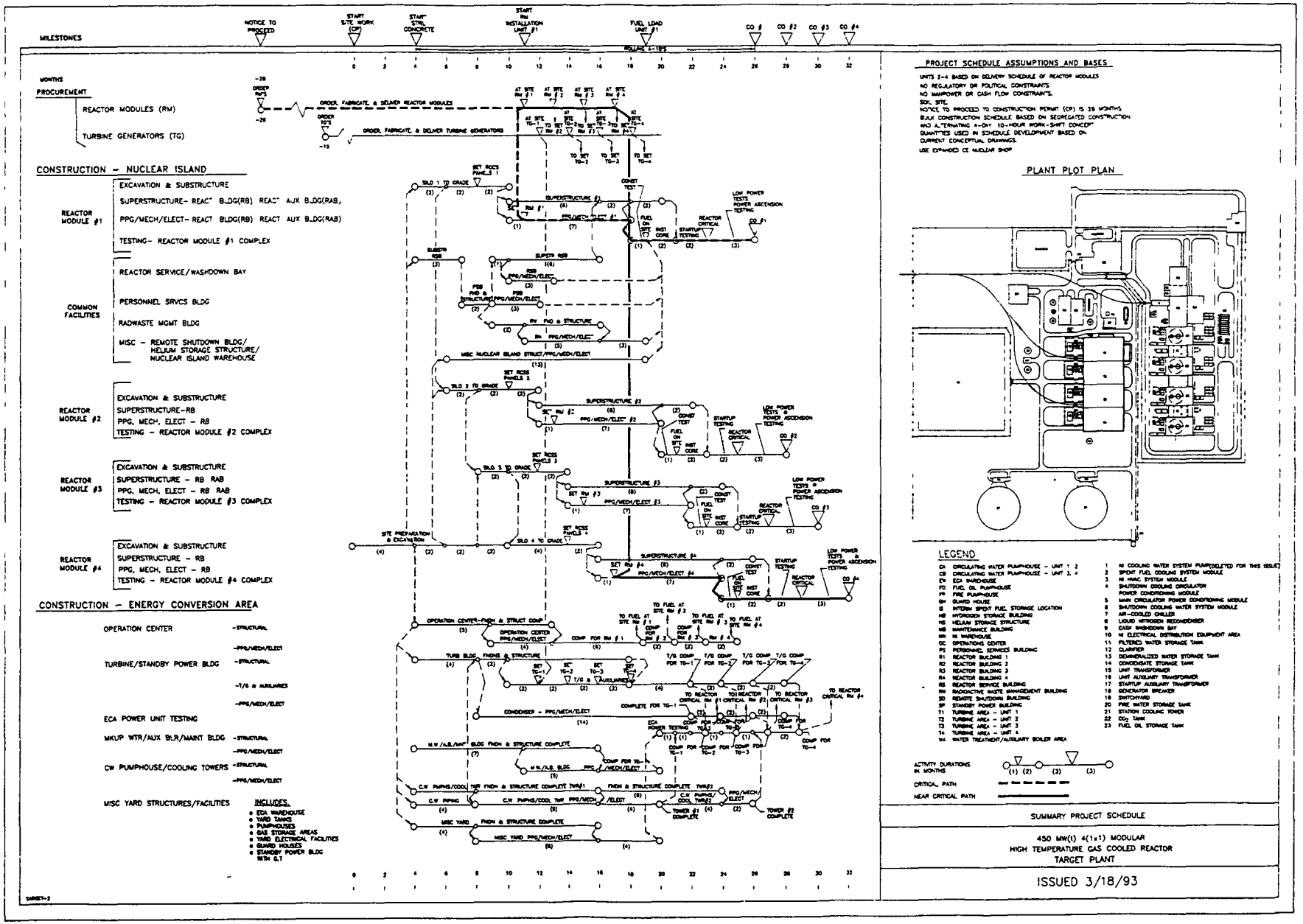
MHTGR-SC PROTOTYPE PLANT (Sheets 1 and 2)
MHTGR-SC TARGET PLANT

MHTGR-GT/IC PROTOTYPE PLANT (Sheets 1 and 2)
MHTGR-GT/IC TARGET PLANT

MHTGR-GT/DC TARGET PLANT


MILESTONES
MONTHS
PROCUREMENT
REACTOR MODULES (7Nr)
TURBINE GENERATORS (7G)
CONSTRUCTION – NUCLEAR ISLAND
REACTOR MODULE #1
EXCAVATION & SUBSTRUCTURE
SUPERSTRUCTURE– REACT BLDG(RB), REACT AUX BLDG(RAB)
PPG/MECH/ELECT– REACT BLDG(RB), REACT AUX BLDG(RAB)
TESTING– REACTOR MODULE #1 COMPLEX
COMMON FACILITIES
REACTOR SERVICE/WASHDOWN BAY
PERSONNEL SRVICS BLDG
RADWASTE MGMT BLDG
MISC – REMOTE SHUTDOWN BLDG/ HELIUM STORAGE STRUCTURE/ NUCLEAR ISLAND WAREHOUSE
REACTOR MODULE #2
EXCAVATION & SUBSTRUCTURE
SUPERSTRUCTURE–RB
PPNL MECH, ELECT – RB
TESTING – REACTOR MODULE #2 COMPLEX
REACTOR MODULE #3
EXCAVATION & SUBSTRUCTURE
SUPERSTRUCTURE – RB, RAB
PPNL MECH, ELECT – RB, RAB
TESTING – REACTOR MODULE #3 COMPLEX
REACTOR MODULE #4
EXCAVATION & SUBSTRUCTURE
SUPERSTRUCTURE – RB
PPNL MECH, ELECT – RB
TESTING – REACTOR MODULE #4 COMPLEX
CONSTRUCTION – ENERGY CONVERSION AREA
OPERATION CENTER
TURBINE/STANDBY POWER BLDG
ECA POWER UNIT TESTING
MISC YARD STRUCTURES/FACILITIES
INCLUDES:
ECA WAREHOUSE
FUEL OIL PUMPHOUSE
FIRE PUMPHOUSE
GAS STORAGE AREAS
MAIN ELECTRICAL FACILITIES
GUARD HOUSES
STANDBY POWER BLDG
PROJECT SCHEDULE ASSUMPTIONS AND BASES
UNITS 3– 4 BASED ON DELIVERY SCHEDULE OF REACTOR MODULES
NO REGULATORY OR POLITICAL CONSTRAINTS.
NO MANPOWER OR CASH FLOW CONSTRAINTS.
SOIL SITE.
NOTICE TO PROCEED TO CONSTRUCTION PERMIT (CP) VARIES AS SHOWN.
BULK CONSTRUCTION SCHEDULE BASED ON SEGREGATED CONSTRUCTION AND 5–DAY 8–HOUR WORK–SHIFT
QUANTITIES USED IN SCHEDULE DEVELOPMENT BASED ON CURRENT CONCEPTUAL DRAWINGS.
USE EXISTING CE NUCLEAR SHOP FOR UNIT #1
USE EXPANDED CE NUCLEAR SHOP FOR UNITS #2 – #4.
PLANT PLOT PLAN
LEGEND
CW CIRCULATING WATER PUMPHOUSE – UNIT 1, 2
CW CIRCULATING WATER PUMPHOUSE – UNIT 3, 4
ECA ECA WAREHOUSE
FO FUEL OIL PUMPHOUSE
FP FIRE PUMPHOUSE
GH GUARD HOUSE
IS INTERIM SPENT FUEL STORAGE LOCATION
HS HYDROGEN STORAGE BUILDING
HS HELIUM STORAGE STRUCTURE
MB MAINTENANCE BUILDING
NI NI WAREHOUSE
OC OPERATIONS CENTER
PS PERSONNEL SERVICES BUILDING
R1 REACTOR BUILDING 1
R2 REACTOR BUILDING 2
R3 REACTOR BUILDING 3
R4 REACTOR BUILDING 4
RB REACTOR SERVICE BUILDING
RW RADIOACTIVE WASTE MANAGEMENT BUILDING
SD REMOTE SHUTDOWN BUILDING
SP STANDBY POWER BUILDING
T1 TURBINE AREA – UNIT 1
T2 TURBINE AREA – UNIT 2
T3 TURBINE AREA – UNIT 3
T4 TURBINE AREA – UNIT 4
WT WATER TREATMENT/AUXILIARY BOILER AREA
1 NI COOLING WATER SYSTEM PUMP (DELETED FOR THIS MODEL)
2 SPENT FUEL COOLING SYSTEM MODULE
3 NI HVAC SYSTEM MODULE
4 SHUTDOWN COOLING CIRCULATOR
POWER CONDITIONING MODULE
5 MAIN CIRCULATOR POWER CONDITIONING MODULE
6 SHUTDOWN COOLING WATER SYSTEM MODULE
7 AIR–COOLED CHILLER
8 LIQUID NITROGEN RECONDENSER
9 CASK WASHDOWN BAY
10 NI ELECTRICAL DISTRIBUTION EQUIPMENT AREA
11 FILTERED WATER STORAGE TANK
12 CLARIFIER
13 DEMINERALIZED WATER STORAGE TANK
14 CONDENSATE STORAGE TANK
15 UNIT TRANSFORMER
16 UNIT AUXILIARY TRANSFORMER
17 STARTUP AUXILIARY TRANSFORMER
18 GENERATOR BREAKER
19 SWITCHYARD
20 FIRE WATER STORAGE TANK
21 STATION COOLING TOWER
22 CO_2 TANK
23 FUEL OIL STORAGE TANK
ACTIVITY SYMBOLS AS SHOWN
CRITICAL PATH
NEAR CRITICAL PATH
SUMMARY PROJECT SCHEDULE
450 MW(t) 4(1x1) MODULAR HIGH TEMPERATURE GAS COOLED REACTOR PROTOTYPE PLANT
SHEET 1 OF 2 ISSUED 3/16/93


MILESTONES
MONTHS
PROCUREMENT
REACTOR MODULES (RM)
TURBINE GENERATORS (TC)
CONSTRUCTION - NUCLEAR ISLAND
REACTOR MODULE #1
EXCAVATION & SUBSTRUCTURE
SUPERSTRUCTURE - REACT BLDG(RB), REACT AUX BLDG(RAB)
PPG/MECH/ELECT - REACT BLDG(RB), REACT AUX BLDG(RAB)
TESTING - REACTOR MODULE #1 COMPLEX
COMMON FACILITIES
REACTOR SERVICE/WASHDOWN BAY
PERSONNEL SRVCS BLDG
RADWASTE MGMT BLDG
MISC - REMOTE SHUTDOWN BLDG/ HELIUM STORAGE STRUCTURE/ NUCLEAR ISLAND WAREHOUSE
REACTOR MODULE #2
EXCAVATION & SUBSTRUCTURE
SUPERSTRUCTURE-RB
PPG, MECH, ELECT - RB
TESTING - REACTOR MODULE #2 COMPLEX
REACTOR MODULE #3
EXCAVATION & SUBSTRUCTURE
SUPERSTRUCTURE - RB, RAB
PPG, MECH, ELECT - RB, RAB
TESTING - REACTOR MODULE #3 COMPLEX
REACTOR MODULE #4
EXCAVATION & SUBSTRUCTURE
SUPERSTRUCTURE - RB
PPG, MECH, ELECT - RB
TESTING - REACTOR MODULE #4 COMPLEX
CONSTRUCTION - ENERGY CONVERSION AREA
OPERATION CENTER
TURBINE/STANDBY POWER BLDG
ECA POWER UNIT TESTING
MISC YARD STRUCTURES/FACILITIES
INCLUDES:
PROJECT SCHEDULE ASSUMPTIONS AND BASES
UNITS 2-4 BASED ON DELIVERY SCHEDULE OF REACTOR MODULES
NO REGULATORY OR POLITICAL CONSTRAINTS
NO MANPOWER OR CASH FLOW CONSTRAINTS
SOIL SITE
NOTICE TO PROCEED TO CONSTRUCTION PERMIT (CP) VARIES AS SHOWN
BULK CONSTRUCTION SCHEDULE BASED ON SEGREGATED CONSTRUCTION AND 5-DAY 8-HOUR WORK-SHIFT
QUANTITIES USED IN SCHEDULE DEVELOPMENT BASED ON CURRENT CONCEPTUAL DRAWINGS.
USE EXISTING GE NUCLEAR SHOP FOR UNIT #1
USE EXPANDED GE NUCLEAR SHOP FOR UNITS #2 - #4.
PLANT PLOT PLAN
LEGEND
CW CIRCULATING WATER PUMPHOUSE - UNIT 1, 2
CW CIRCULATING WATER PUMPHOUSE - UNIT 3, 4
ECA WAREHOUSE
FUEL OIL PUMPHOUSE
FIRE PUMPHOUSE
GUARD HOUSE
INTERIM SPENT FUEL STORAGE LOCATION
HYDROGEN STORAGE BUILDING
HELIUM STORAGE STRUCTURE
MAINTENANCE BUILDING
WAREHOUSE
OPERATIONS CENTER
PERSONNEL SERVICES BUILDING
REACTOR BUILDING 1
REACTOR BUILDING 2
REACTOR BUILDING 3
REACTOR BUILDING 4
REACTOR SERVICE BUILDING
RADIOACTIVE WASTE MANAGEMENT BUILDING
REMOTE SHUTDOWN BUILDING
STANDBY POWER BUILDING
TURBINE AREA - UNIT 1
TURBINE AREA - UNIT 2
TURBINE AREA - UNIT 3
TURBINE AREA - UNIT 4
WATER TREATMENT/AUXILIARY BOILER AREA
1 HE COOLING WATER SYSTEM PUMP (DELETED FOR THIS GWO)
2 SPENT FUEL COOLING SYSTEM MODULE
3 RB HVAC SYSTEM MODULE
4 SHUTDOWN COOLING CIRCULATOR
POWER CONDITIONING MODULE
5 MAIN CIRCULATOR POWER CONDITIONING MODULE
6 SHUTDOWN COOLING WATER SYSTEM MODULE
7 AIR-COOLED CHILLER
8 LIQUID NITROGEN RECONDENSER
9 CASK WASHDOWN BAY
10 RB ELECTRICAL DISTRIBUTION EQUIPMENT AREA
11 FILTERED WATER STORAGE TANK
12 CLARIFIER
13 DEMINERALIZED WATER STORAGE TANK
14 CONDENSATE STORAGE TANK
15 UNIT TRANSFORMER
16 UNIT AUXILIARY TRANSFORMER
17 STARTUP AUXILIARY TRANSFORMER
18 GENERATOR BREAKER
19 SWITCHYARD
20 FIRE WATER STORAGE TANK
21 STATION COOLING TOWER
22 CO_2 TANK
23 FUEL OIL STORAGE TANK
ACTIVITY DURATIONS IN MONTHS
CRITICAL PATH
NEAR CRITICAL PATH
SUMMARY PROJECT SCHEDULE
450 MW(t) 4(1x1) MODULAR
HIGH TEMPERATURE GAS COOLED REACTOR
PROTOTYPE PLANT
SHEET 2 OF 2 ISSUED 3/18/93



PROJECT SCHEDULE ASSUMPTIONS AND BASES

UNITS 2–4 BASED ON DELIVERY SCHEDULE OF REACTOR MODULES
NO REGULATORY OR POLITICAL CONSTRAINTS
NO MANPOWER OR CASH FLOW CONSTRAINTS.
SOIL SITE.
NOTICE TO PROCEED TO CONSTRUCTION PERMIT (CP) IS 28 MONTHS
BULK CONSTRUCTION SCHEDULE BASED ON SEGREGATED CONSTRUCTION AND ALTERNATING 4–DAY 10–HOUR WORK–SHIFT CONCEPT
QUANTITIES USED IN SCHEDULE DEVELOPMENT BASED ON CURRENT CONCEPTUAL DRAWINGS.
USE EXPANDED CE NUCLEAR SHOP

PLANT PLOT PLAN

LEGEND

CA CIRCULATING WATER PUMPHOUSE – UNIT 1, 2	1 NI COOLING WATER SYSTEM PUMP(DELETED FOR THIS ISSUE)
CB CIRCULATING WATER PUMPHOUSE – UNIT 3, 4	2 SPENT FUEL COOLING SYSTEM MODULE
EA ECA WAREHOUSE	3 NI HVAC SYSTEM MODULE
FO FUEL OIL PUMPHOUSE	4 SHUTDOWN COOLING CIRCULATOR
FP FIRE PUMPHOUSE	POWER CONDITIONING MODULE
GH GUARD HOUSE	5 MAIN CIRCULATOR POWER CONDITIONING MODULE
IS INTERIM SPENT FUEL STORAGE LOCATION	6 SHUTDOWN COOLING WATER SYSTEM MODULE
HB HYDROGEN STORAGE BUILDING	7 AIR–COOLED CHILLER
HS HELIUM STORAGE STRUCTURE	8 LIQUID NITROGEN RECONDENSER
MB MAINTENANCE BUILDING	9 CASK WASHDOWN BAY
WH NI WAREHOUSE	10 NI ELECTRICAL DISTRIBUTION EQUIPMENT AREA
OC OPERATIONS CENTER	11 FILTERED WATER STORAGE TANK
PS PERSONNEL SERVICES BUILDING	12 CLARIFIER
R1 REACTOR BUILDING 1	13 DEMINERALIZED WATER STORAGE TANK
R2 REACTOR BUILDING 2	14 CONDENSATE STORAGE TANK
R3 REACTOR BUILDING 3	15 UNIT TRANSFORMER
R4 REACTOR BUILDING 4	16 UNIT AUXILIARY TRANSFORMER
RS REACTOR SERVICE BUILDING	17 STARTUP AUXILIARY TRANSFORMER
RW RADIOACTIVE WASTE MANAGEMENT BUILDING	18 GENERATOR BREAKER
SD REMOTE SHUTDOWN BUILDING	19 SWITCHYARD
SP STANDBY POWER BUILDING	20 FIRE WATER STORAGE TANK
T1 TURBINE AREA – UNIT 1	21 STATION COOLING TOWER
T2 TURBINE AREA – UNIT 2	22 CO_2 TANK
T3 TURBINE AREA – UNIT 3	23 FUEL OIL STORAGE TANK
T4 TURBINE AREA – UNIT 4	
WA WATER TREATMENT/AUXILIARY BOILER AREA	

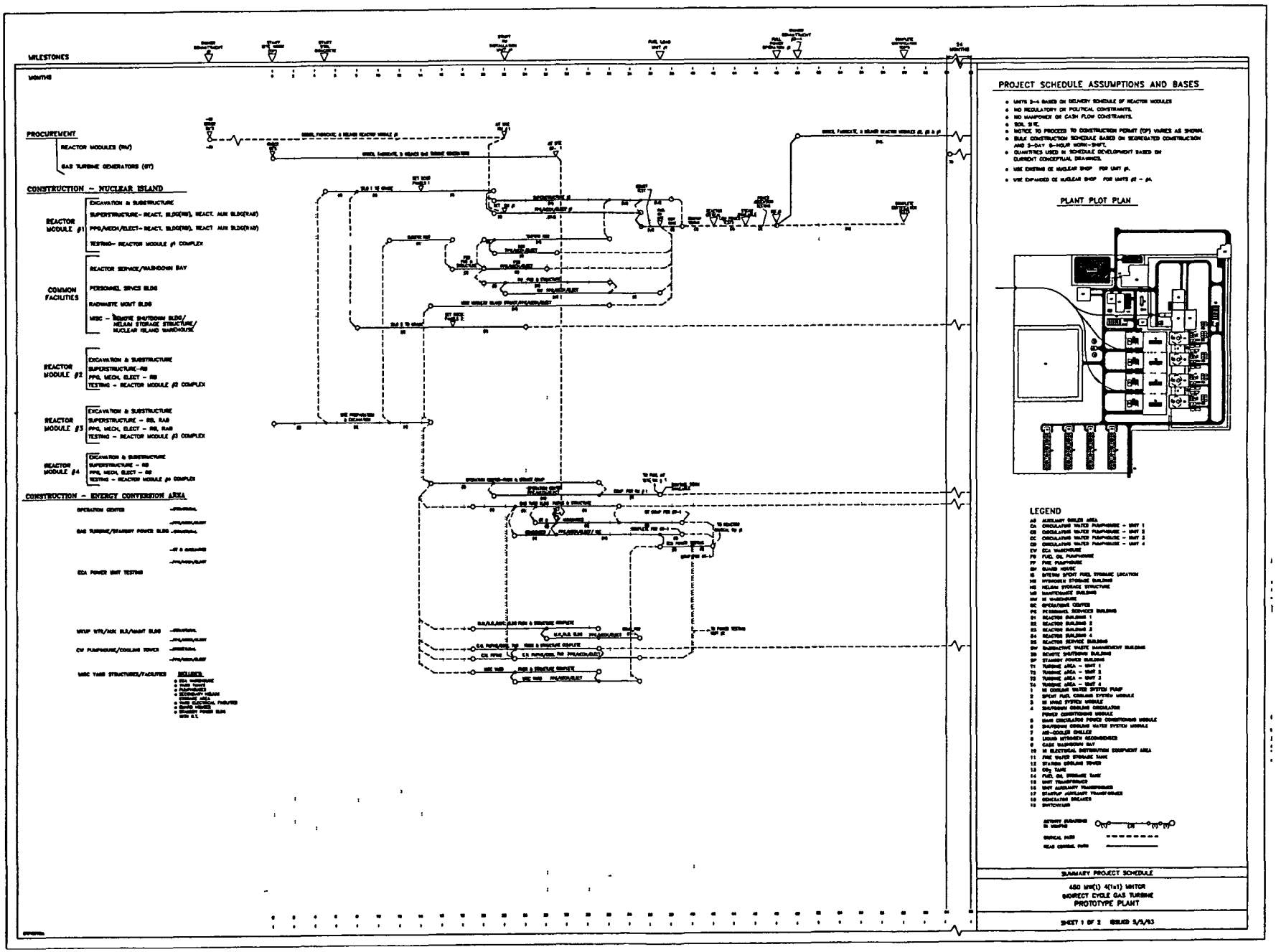
ACTIVITY DURATIONS IN MONTHS (1) (2) (3) (3)
CRITICAL PATH
NEAR CRITICAL PATH

SUMMARY PROJECT SCHEDULE

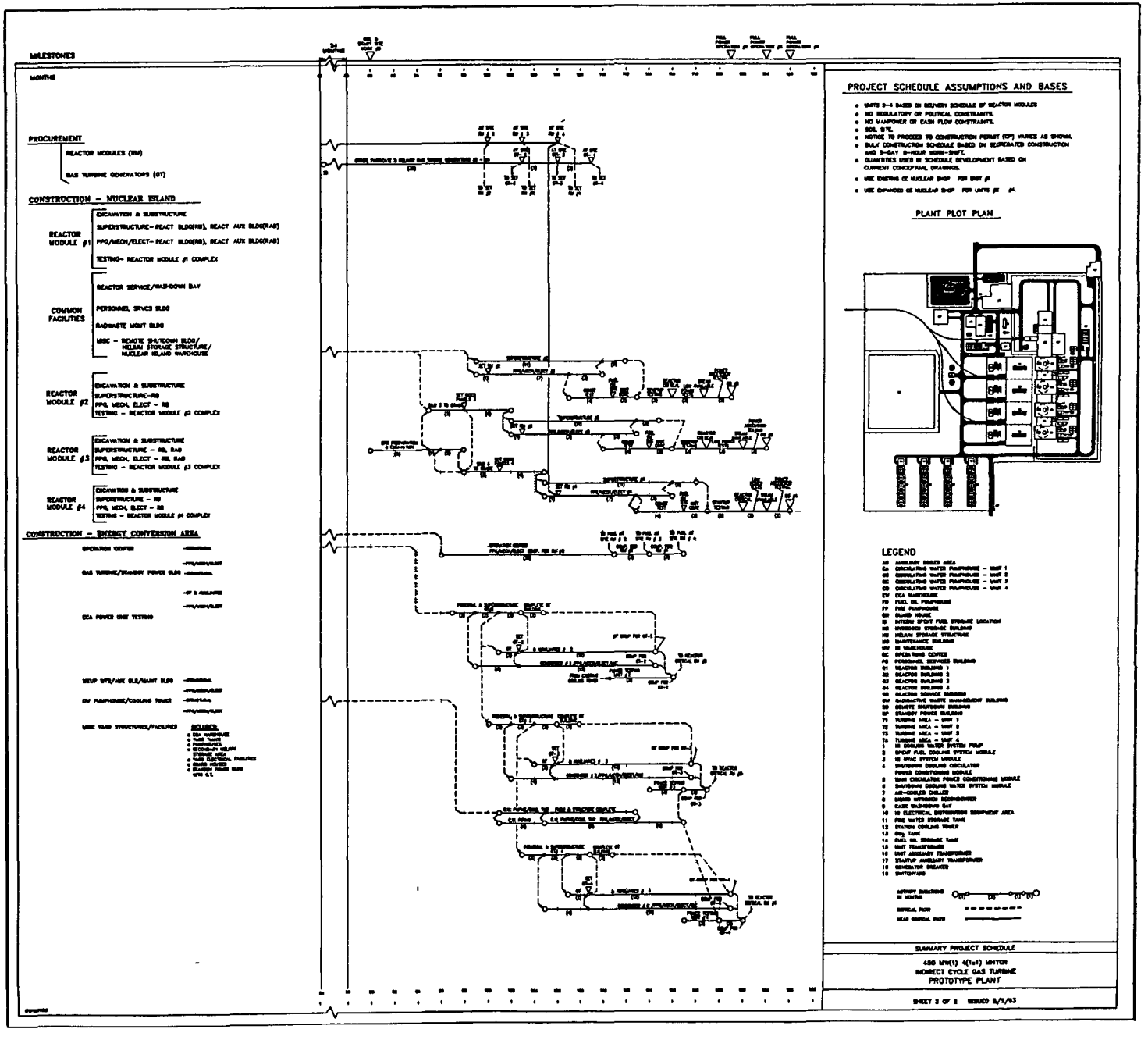
450 MW(t) 4(1x1) MODULAR
HIGH TEMPERATURE GAS COOLED REACTOR
TARGET PLANT

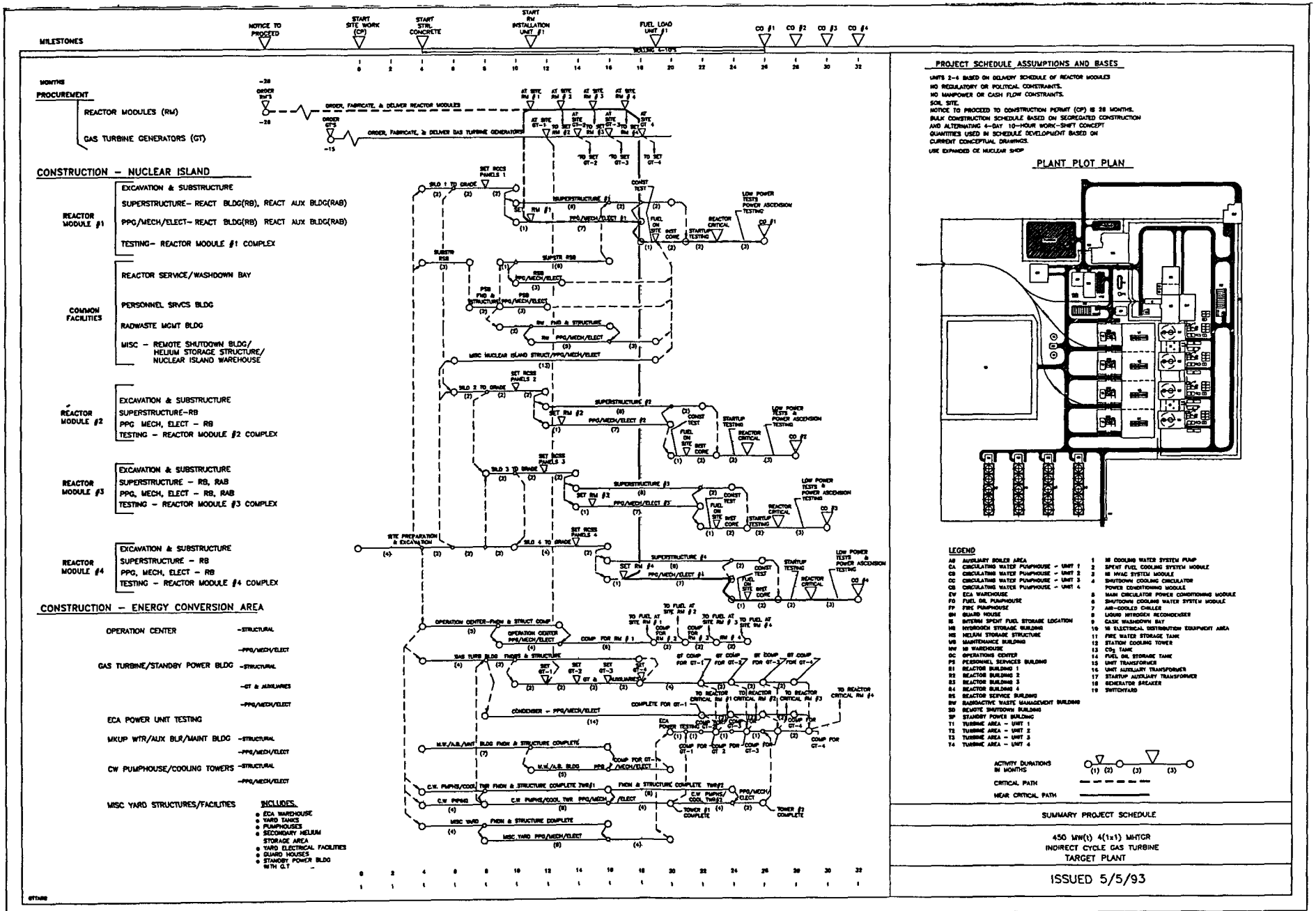
ISSUED 3/18/93

D-2
MHTGR-SC TARGET PLANT



D-3
MHTGR-GT/IC PROTOTYPE PLANT


MILESTONES
MONTHS
PROCUREMENT
REACTOR MODULES (RM)
GAS TURBINE GENERATORS (GT)
CONSTRUCTION – NUCLEAR ISLAND
REACTOR MODULE #1
EXCAVATION & SUBSTRUCTURE
SUPERSTRUCTURE– REACT BLDG(RB), REACT AUX BLDG(RAB)
PPG/MECH/ELECT– REACT BLDG(RB), REACT AUX BLDG(RAB)
TESTING– REACTOR MODULE #1 COMPLEX
COMMON FACILITIES
REACTOR SERVICE/WASHDOWN BAY
PERSONNEL SRVCS BLDG
RADWASTE MGMT BLDG
MISC – REMOTE SHUTDOWN BLDG/ HELIUM STORAGE STRUCTURE/ NUCLEAR ISLAND WAREHOUSE
REACTOR MODULE #2
EXCAVATION & SUBSTRUCTURE
SUPERSTRUCTURE–RB
PPG, MECH, ELECT – RB
TESTING – REACTOR MODULE #2 COMPLEX
REACTOR MODULE #3
EXCAVATION & SUBSTRUCTURE
SUPERSTRUCTURE – RB, RAB
PPG, MECH, ELECT – RB, RAB
TESTING – REACTOR MODULE #3 COMPLEX
REACTOR MODULE #4
EXCAVATION & SUBSTRUCTURE
SUPERSTRUCTURE – RB
PPG, MECH, ELECT – RB
TESTING – REACTOR MODULE #4 COMPLEX
CONSTRUCTION – ENERGY CONVERSION AREA
OPERATION CENTER
GAS TURBINE/STANDBY POWER BLDG
EGA POWER UNIT TESTING
MISC YARD STRUCTURES/FACILITIES
INCLUDE:
EGA WAREHOUSE
FUEL OIL PUMPHOUSE
FIRE PUMPHOUSE
GUARD HOUSE
SECONDARY HELIUM STORAGE AREA
YARD ELECTRICAL FACILITIES
STANDBY POWER BLDG
WTR C.T.
PROJECT SCHEDULE ASSUMPTIONS AND BASES
UNITS 2–4 BASED ON DELIVERY SCHEDULE OF REACTOR MODULES
NO REGULATORY OR POLITICAL CONSTRAINTS.
NO MANPOWER OR CASH FLOW CONSTRAINTS.
SOIL SITE.
NOTICE TO PROCEED TO CONSTRUCTION PERMIT (CP) VARIES AS SHOWN.
BULK CONSTRUCTION SCHEDULE BASED ON SEGREGATED CONSTRUCTION AND 5-DAY 8-HOUR WORK-SHIFT.
QUANTITIES USED IN SCHEDULE DEVELOPMENT BASED ON CURRENT CONCEPTUAL DRAWINGS.
USE EXISTING OR NUCLEAR SHOP FOR UNIT #1
USE EXPANDED OR NUCLEAR SHOP FOR UNITS #2 #4.
PLANT PLOT PLAN
LEGEND
ACTIVITY DURATION IN MONTHS
CRITICAL PATH
NEAR CRITICAL PATH
SUMMARY PROJECT SCHEDULE
450 MW(t) 4(1+1) MHTGR
INDIRECT CYCLE GAS TURBINE
PROTOTYPE PLANT
SHEET 2 OF 2 ISSUED 8/1/93



PROJECT SCHEDULE ASSUMPTIONS AND BASES

UNITS 2–4 BASED ON DELIVERY SCHEDULE OF REACTOR MODULES
NO REGULATORY OR POLITICAL CONSTRAINTS.
NO MANPOWER OR CASH FLOW CONSTRAINTS.
SOIL SITE.
NOTICE TO PROCEED TO CONSTRUCTION PERMIT (CP) IS 28 MONTHS.
BULK CONSTRUCTION SCHEDULE BASED ON SEGREGATED CONSTRUCTION AND ALTERNATING 4–DAY 10–HOUR WORK–SHIFT CONCEPT
QUANTITIES USED IN SCHEDULE DEVELOPMENT BASED ON CURRENT CONCEPTUAL DRAWINGS.
USE EXPANDED OE NUCLEAR SHOP

PLANT PLOT PLAN

LEGEND

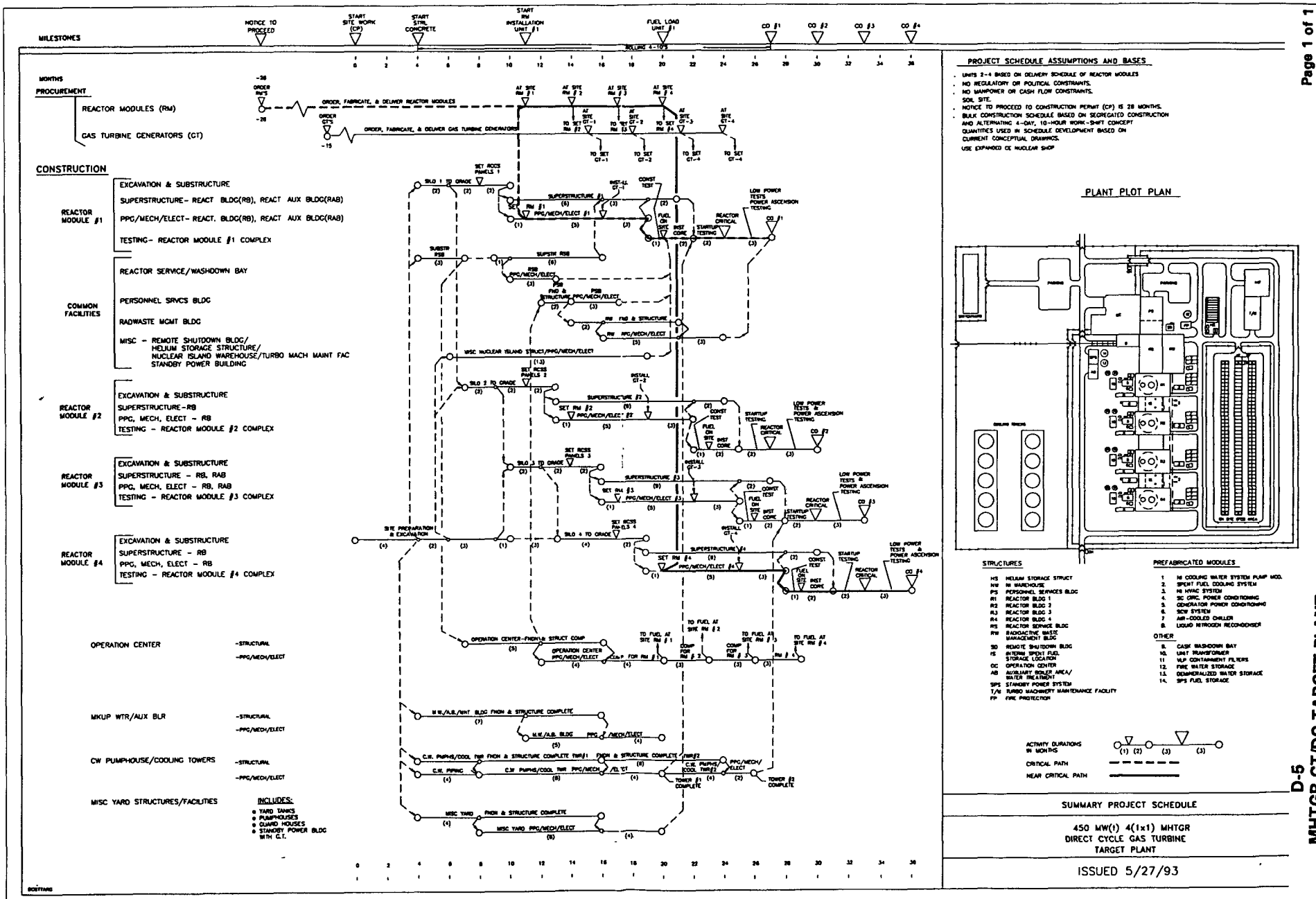
AB	AUXILIARY BOILER AREA	1	10 COOLING WATER SYSTEM PUMP
CA	CIRCULATING WATER PUMPHOUSE – UNIT 1	2	SPENT FUEL COOLING SYSTEM MODULE
CB	CIRCULATING WATER PUMPHOUSE – UNIT 2	3	10 HVAC SYSTEM MODULE
CC	CIRCULATING WATER PUMPHOUSE – UNIT 3	4	SHUTDOWN COOLING CIRCULATOR POWER CONDITIONING MODULE
CD	CIRCULATING WATER PUMPHOUSE – UNIT 4	5	MAIN CIRCULATOR POWER CONDITIONING MODULE
EW	ECA WAREHOUSE	6	SHUTDOWN COOLING WATER SYSTEM MODULE
FO	FUEL OIL PUMPHOUSE	7	AIR–COOLED CHILLER
FP	FIRE PUMPHOUSE	8	LIQUID NITROGEN RECONDENSER
GH	GUARD HOUSE	9	CASK WASHDOWN BAY
IS	INTERIM SPENT FUEL STORAGE LOCATION	10	10 ELECTRICAL DISTRIBUTION EQUIPMENT AREA
MB	HYDROGEN STORAGE BUILDING	11	FIRE WATER STORAGE TANK
MS	HELIUM STORAGE STRUCTURE	12	STATION COOLING TOWER
MW	MAINTENANCE BUILDING	13	CO_2 TANK
NW	10 WAREHOUSE	14	FUEL OIL STORAGE TANK
OC	OPERATIONS CENTER	15	UNIT TRANSFORMER
PS	PERSONNEL SERVICES BUILDING	16	UNIT AUXILIARY TRANSFORMER
R1	REACTOR BUILDING 1	17	STARTUP AUXILIARY TRANSFORMER
R2	REACTOR BUILDING 2	18	GENERATOR BREAKER
R3	REACTOR BUILDING 3	19	SWITCHYARD
R4	REACTOR BUILDING 4		
RS	REACTOR SERVICE BUILDING		
RW	RADIOACTIVE WASTE MANAGEMENT BUILDING		
SD	REMOTE SHUTDOWN BUILDING		
SP	STANDBY POWER BUILDING		
T1	TURBINE AREA – UNIT 1		
T2	TURBINE AREA – UNIT 2		
T3	TURBINE AREA – UNIT 3		
T4	TURBINE AREA – UNIT 4		

ACTIVITY DURATIONS IN MONTHS (1) (2) (3) (3)
CRITICAL PATH
NEAR CRITICAL PATH

SUMMARY PROJECT SCHEDULE

450 MW(t) 4(1x1) MHTGR
INDIRECT CYCLE GAS TURBINE
TARGET PLANT

ISSUED 5/5/93



PROJECT SCHEDULE ASSUMPTIONS AND BASES

- UNITS 2-4 BASED ON DELIVERY SCHEDULE OF REACTOR MODULES
- NO REGULATORY OR POLITICAL CONSTRAINTS.
- NO MANPOWER OR CASH FLOW CONSTRAINTS.
- SOIL SITE.
- NOTICE TO PROCEED TO CONSTRUCTION PERMIT (CP) IS 28 MONTHS.
- BULK CONSTRUCTION SCHEDULE BASED ON SEGREGATED CONSTRUCTION AND ALTERNATING 4-DAY, 10-HOUR WORK-SHIFT CONCEPT
- QUANTITIES USED IN SCHEDULE DEVELOPMENT BASED ON CURRENT CONCEPTUAL DRAWINGS.
- USE EXPANDED CE NUCLEAR SHOP

PLANT PLOT PLAN

STRUCTURES

- HS HELIUM STORAGE STRUCT
- NW NI WAREHOUSE
- PS PERSONNEL SERVICES BLDG
- R1 REACTOR BLDG 1
- R2 REACTOR BLDG 2
- R3 REACTOR BLDG 3
- R4 REACTOR BLDG 4
- RS REACTOR SERVICE BLDG
- RW RADIOACTIVE WASTE MANAGEMENT BLDG
- SD REMOTE SHUTDOWN BLDG
- IS INTERIM SPENT FUEL STORAGE LOCATION
- OC OPERATION CENTER
- AB AUXILIARY BOILER AREA/ WATER TREATMENT
- SPS STANDBY POWER SYSTEM
- T/M TURBO MACHINERY MAINTENANCE FACILITY
- FP FIRE PROTECTION

PREFABRICATED MODULES

1. NI COOLING WATER SYSTEM PUMP MOD.
2. SPENT FUEL COOLING SYSTEM
3. NI HVAC SYSTEM
4. SC CIRC. POWER CONDITIONING
5. GENERATOR POWER CONDITIONING
6. SCW SYSTEM
7. AIR-COOLED CHILLER
8. LIQUID NITROGEN RECONDENSER

OTHER

9. CASK WASHDOWN BAY
10. UNIT TRANSFORMER
11. VLP CONTAINMENT FILTERS
12. FIRE WATER STORAGE
13. DEMINERALIZED WATER STORAGE
14. SPS FUEL STORAGE

ACTIVITY DURATIONS IN MONTHS (1) (2) (3) (3)

CRITICAL PATH

NEAR CRITICAL PATH

SUMMARY PROJECT SCHEDULE

450 MW(t) 4(1x1) MHTGR DIRECT CYCLE GAS TURBINE TARGET PLANT

ISSUED 5/27/93