Power System Programs

MASTER

Global Spent Fuel Logistics Systems Study (GSFLS)

Contract No. EN-77-C-03-1583

Volume 1 : GSFLS Summary Report

June 1978

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**BOEING
ENGINEERING &
CONSTRUCTION**
*THE BOEING ENERGY
AND ENVIRONMENT DIVISION*

Power System Programs

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June 1978

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ABSTRACT

An important element in the implementation of international nuclear energy policies is the creation of viable systems for transporting, handling, storing, and disposing of the world's spent nuclear fuel. There is an urgent need to implement selected global spent fuel logistics systems (GSFLS) which can best bridge the interests of countries throughout the world and provide the necessary means for transporting, handling, storing and disposing of spent nuclear fuel. The viability of these systems depends upon their compatibility with governmental policies and nonproliferation concerns; their adequacy in support of projected global nuclear power programs; and their adaptation to realistic technological and institutional constraints.

The United States Department of Energy contracted with Boeing Engineering and Construction (BEC), a division of the Boeing Company, and its subcontractors, International Energy Associates Limited (IEAL) and the firm of Doub, Purcell, Muntzing and Hansen to conduct a study of issues and options in establishing GSFLS and to develop preliminary GSFLS concepts. BEC conducted the study integration and developed the technological/economic framework; IEAL researched and developed the institutional framework; and the firm of Doub, Purcell, Muntzing and Hansen conducted the legal/regulatory research associated with the study. BEC also consulted with the First Boston Corporation regarding generic financial considerations associated with GSFLS.

This report provides a summarization of the GSFLS study findings.

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LIST OF ABBREVIATIONS

The following abbreviations are used in this report.

AFR -	Away-from-Reactor
ARS -	At-Reactor Storage
BNFL -	British Nuclear Fuels Limited
COGEMA -	Compagnie Générale des Matières Nucléaires
ECC -	European Economic Community
ERE -	European Regional Enterprise
ERSFLS -	European Regional Spent Fuel Logistics System
FCC -	Fuel Cycle Center
FCC-C -	Fuel Cycle Center - Geologic
GSFLS -	Global Spent Fuel Logistics System
HLW -	High Level Waste
IAEA -	International Atomic Energy Agency
INFCE -	International Nuclear Fuel Cycle Evaluation
KgHM -	Kilogram of Heavy Metal
KgU -	Kilogram of Uranium
LWR -	Light Water Reactor
MTHM -	Metric Ton of Heavy Metal
MTU -	Metric Ton of Uranium
NPT -	Non Proliferation Treaty
NTL -	Nuclear Transport Limited
NTS -	National Transport Services
PBC -	Pacific Basin Consortium
PBSFLS -	Pacific Basin Spent Fuel Logistics System
PNTL -	Pacific Nuclear Transport Limited
Pu -	Plutonium
RBC -	Reprocessing Business Coordination
ROC -	Republic of China
ROK -	Republic of Korea
TN -	Trans Nuclear
U.K. -	United Kingdom
URG -	United Reprocessing Group
U.S. -	United States

1.0 INTRODUCTION

An inevitable by-product of the world's existing and future nuclear power programs is the generation and discharge of spent nuclear fuel from power reactors. Global Spent Fuel Logistics Systems (GSFLS) are defined to be those away-from-reactor (AFR) systems required to transport, handle, store and dispose of spent nuclear fuel. The GSFLS study was undertaken to accomplish the following objectives:

1.1 STUDY OBJECTIVES

- Identify and evaluate relevant technical, economic, regulatory, legal, financial, and political considerations related to GSFLS.
- Conceptualize GSFLS capable of transporting, storing and disposing of spent fuel being generated by nuclear power reactors in various countries.
- Identify the steps required to implement selected GSFLS concepts.
- Assess institutional interest in implementing selected GSFLS concepts.

1.2 STUDY CONTENT

In support of the study objectives stated in Section 1.1, the GSFLS study accomplished the following tasks:

- (1) A quantitative and strategic GSFLS framework was developed in order to provide the basis for conceptualizing elements of a GSFLS.
- (2) Selected GSFLS concepts were developed.
- (3) A preliminary assessment of institutional interest in a selected GSFLS concept was made.

A GSFLS framework which evaluated relevant technical, economic, financial, legal/regulatory and political considerations was developed as follows:

- A broad sampling of foreign governmental officials, electric utility spokesmen and nuclear power industry officials responsible for GSFLS policies, plans, and programs were surveyed as to their views with respect to national and international GSFLS related considerations. An evaluation of the survey results, in conjunction with supplementary research, provided a basis for (a) evaluating technical, institutional, and legal/regulatory considerations; and (b) developing alternative GSFLS strategies.
- The technical, economic and financial considerations associated with GSFLS were evaluated. Spent fuel profiles were used to determine the technical systems requirements for alternative concepts. Functional analyses and flows were generated to define both system design requirements and logistics parameters. A technology review was made to ascertain the state-of-the-art of relevant GSFLS elements. Modular GSFLS

facility designs were developed using the information generated from the functional analysis and technical review. The modular facility designs were used as a basis for siting and cost estimates for various GSFLS alternatives. Various GSFLS concepts were analyzed from a financial and economic perspective in order to provide total concepts costs and ascertain sensitivities to key GSFLS variations. Results of the technical/financial study included quantification of GSFLS facility and hardware requirements; drawings of relevant GSFLS facility designs; system cost estimates; financial reports - including user service charges; and comparative analyses of various GSFLS alternatives.

Based on the results of the GSFLS framework, technical and institutional GSFLS concepts were developed for the Pacific Basin and Europe. Preliminary institutional interest with respect to the implementation of a Pacific Basin Spent Fuel Logistics System concept was obtained.

The GSFLS study is documented in the following way:

Volume 1:	<u>GSFLS Summary Report</u>
Volume 2*:	<u>GSFLS Visit Findings and Evaluations</u>
Volume 2A*:	<u>GSFLS Visit Findings</u> (Appendix)
Volume 3*:	<u>GSFLS Technical & Financial Analysis</u>
Volume 3A*:	<u>GSFLS Technical Analysis</u> (Appendix)
Volume 3B*:	<u>GSFLS Financial-Economic Analysis</u> (Appendices)
Volume 4:	<u>Pacific Basin Spent Fuel Logistics System</u>
Volume 5:	<u>European Spent Fuel Logistics System</u>

*GSFLS Interim Report

This report (Volume 1 - GSFLS Summary Report) provides the following summarization of the GSFLS study:

Part I: GSFLS Framework

Summarizes the study findings and evaluations that provide a framework for conceptualizing selected GSFLS.

Part II: Pacific Basin Spent Fuel Logistics Systems (PBSFLS) Concept

Summarizes the basis for and elements of a recommended concept for a spent fuel logistics system serving Pacific Basin countries. In addition, a recommended institutional and technological implementation plan is provided.

Part III: European Regional Spent Fuel Logistics System (ERSFLS) Concepts

Summarizes conceptual options for a spent fuel logistics system serving the European region.

Appendices: Provides supplemental information on Candidate Organizational Models and Materials Accountability and Control Regime considerations.

2.0 GSFLS STUDY SUMMARY

2.1 REQUIREMENT FOR GLOBAL SPENT FUEL LOGISTICS SYSTEMS (GSFLS)

Significant future growth is projected for the quantities of global spent fuel requiring away-from-reactor (AFR) spent fuel disposition and supportive GSFLS. Figure 2-1 illustrates the geographical distribution of projected AFR spent fuel disposition needs. The basis for Figure 2-1 is as follows:

- a) Only Light Water Reactors (LWR) were considered in the study's reactor population; and it was assumed that no additional LWR's will be brought on line after the year 2000.
- b) Centrally Planned Economies (CPE) reactors were not included.
- c) Wherever possible, actual reactor discharge data and at-reactor storage capacities (ARS) was used for known reactor programs - i.e., those in operation, under construction or planned reactors.
- d) Wherever possible, actual reactor ARS plans were considered. Where specific ARS plans were not available, a 5 year ARS period was used.

Figure 2-1 illustrates an important characteristic within the GSFLS framework, namely, that there are three distinctly different generic phases (time periods) which must be reconciled within a GSFLS strategy. These phases include:

Figure 2-1: Away-From-Reactor Spent Fuel Disposition Profile

Near Term Phase (Pre-1983 $\pm$ 2 years)

The near term phase has relatively small cumulative spent fuel for AFR disposition. Solutions for near term fuel disposition need not pre-empt more optimal longer term solutions.

Intermediate Term Phase (1983 to 2000)

The intermediate term is viewed as the most critical GSFLS time period in that appropriate decisions and actions must be taken in order (a) to accommodate the relatively large AFR spent fuel disposition requirements occurring in that phase and (b) to provide the appropriate spent fuel disposition systems that can support longer term energy resource recovery programs.

Long Term Phase (2000 to 2030)

All major spent fuel disposition decisions and implementation programs must be completed during the intermediate term phase in order to have a viable long term nuclear power program.

2.2 NATIONAL SPENT FUEL DISPOSITION STRATEGIES

National spent fuel disposition strategies are guided by the following considerations:

- Availability of indigeneous or assured fuel cycle supply and perceived fuel cycle economics.
- Involvement in plutonium breeder development and commercialization activities.
- Nuclear waste management policies, practices and constraints.
- Nonproliferation concerns and policies

Figure 2-2 catagorizes selected country (or country groupings) spent fuel disposition strategies - as influenced by the above mentioned considerations. Although multiple considerations generally affect spent fuel disposition strategies, an attempt was made to identify principal considerations underlying specific strategies.

Figure 2-2

DOMINANT NATIONAL CONCERNS, PREFERRED APPROACHES, AND MAJOR PROGRAM PRIORITIES

DOMINANT NAT'L
CONCERNS

NATIONS/DOMINANT
CONCERNS GROUPINGS

PREFERRED
APPROACHES

MAJOR PROGRAM
PRIORITIES

WASTE MANAGEMENT -
ORIENTED GROUP

Austria
Denmark
Finland
Luxemburg²
Netherlands¹
Norway
ROC
ROK
Sweden
Switzerland
United States

Conditional/
Deferred
Reprocessing;
Preferably
Mid-to-late
term
Reprocessing
(past 1990)

ARS expansion,
AFR Planning
Permanent Storage
Options

NAT'L REPROCESSING -
ORIENTED GROUP

Belgium¹
France¹
FRG^{1,2}
Japan
Italy¹
Spain
U.K.

Early to
Mid-Term
Reprocessing
(pre 1990)

Fuel Cycle
Economics,
and/or Breeder
Development
Requirements³

- 1 - SERENA Agreement Signators
- 2 - Luxemburg will follow FRG's waste management options
- 3 - Does not preclude AFR and permanent disposal planning

2.3 GSFLS RATIONALE

The conduct of the study requires a generic definition of spent fuel policy objectives as they would apply to specific world regions and countries. An estimate of these objectives has been developed to support the assessment of GSFLS strategies.

The study assumes a generic policy with respect to the disposition of spent fuel to be an integral part of a policy directed toward the deferral of reprocessing and the consequent accumulation and dispersion of weapons-useable plutonium, until the proliferation risks are viewed by nations to be at acceptable levels. While spent nuclear fuel from present day light water or heavy water reactors is not a weapons-useable material, it represents a proliferation risk in two respects:

- The accumulation of spent fuel, especially in sensitive countries or regions, constitutes a source of plutonium if and when a country in which it is located decides upon and achieves a reprocessing capability, and the ready availability of spent fuel may even stimulate a decision to engage in reprocessing for military reasons.
- In some countries, the long term storage of spent fuel is viewed as unacceptable, creating pressures for reprocessing as a means of alleviating the storage problem, with the consequent production of weapons-useable plutonium.

The alternative strategy development process of the study draws on imputed nonproliferation values of international or multinational arrangements in dealing with spent fuel management.

The need for internationalization of the fuel cycle has generated much discussion, developing a range of views. These include advocating to:

- a) put the entire fuel cycle in place at one time (assuming reprocessing)
- b) put in place a system dedicated to the once-through cycle and leading to permanent storage of unprocessed spent fuel
- c) put in place a fuel cycle system which can adjust to the technical and institutional non-proliferation solutions as they are developed and accepted by nations.

These views or approaches must, of course, make sense to participating nations and industries in order to be implemented, and it is possible that more than one of these approaches will become a reality.

The approach of this study centers on the third choice - to put in place a fuel cycle system which can adjust to the technical and institutional nonproliferation solutions as they are developed and accepted by nations. The approach centers on the concept of centralized large scale spent fuel storage under international or multinational auspices or control. The concept does not imply affirmative decision making for reprocessing, nor does it rule out later reprocessing if agreement has been reached on the technical and institutional conditions required to make reprocessing an accepted activity from the nonproliferation standpoint. The concept is structured to relieve spent fuel logistics pressures and provide a basis for accommodating longer term decisions on fuel cycle management. For the purposes of this study, the assumed nonproliferation values of the international or multinational arrangements in such a concept are summarized as follows:

- a) Relief of pressure for premature fuel movement into a reprocessing system: The study country findings identify a significant amount of spent fuel positioned or potentially positioned for movement into domestic or foreign reprocessing systems. The absence of a workable spent fuel storage alternative providing a reprocessing deferral scenario provides a continued pressure for solutions dependent upon near term and intermediate reprocessing decisions.

It should be clear in an international storage scheme that reprocessing (or other recovery function) would not take place unless the nonproliferation concerns were resolved for such an operation and that it was agreed that reprocessing was desirable from the view of economics and resource conservation in certain countries. In addition to relieving the pressure for reprocessing decisions, the international storage, if under multinational custody as well as IAEA safeguards, could, under appropriate siting and other conditions, provide greater storage security than national storage.

- b) Reduction of incentives for national fuel cycle activities, including national reprocessing: The centralized collection of spent fuel from a number of nations can be effected to favor international solutions in the disposition decisions following storage. International solutions in areas such as reprocessing provide an important intrinsic nonproliferation advantage over national reprocessing because of the possibilities of strengthened nonproliferation assurance obtainable from international arrangements.

Again in the case of reprocessing, the existence of a national facility in a particular region could be destabilizing to countries in the region which might believe they need a national facility to balance against proliferation uncertainties.

Obviously, a country with an identified national reprocessing facility has a significant advantage if it chooses to abrogate its safeguard and peaceful uses obligations.

2.4 GSFLS TECHNOLOGICAL FRAMEWORK

The technological GSFLS framework supportive of the GSFLS rationale (described in Section 2.3) is as follows:

- a) The global spent fuel disposition system would be made up of several regional elements. This allows the advantages of scale factor without overburdening the system with large transportation problems.
- b) System start-up would occur by 1985. Commulative spent fuel shipped to the regional center by year 2000 would be approximately 20,000 MTHM. In a "deferral scenario" this fuel would be placed in a complex of retrievable spent fuel storage facilities until a recovery decision was made.

Cummulative spent fuel shipped to the regional center by year 2030 (end of study reference period) would exceed 100,000 MTHM. This fuel would likely be processed for resource recovery by an acceptable (nonproliferation) recovery alternative.

- c) System elements would include:
 - 1) Transportation: GSFLS transportation elements would include casks, cask transportation, special spent fuel transport ships (as required). Figure 2-3 shows the spent fuel transportation requirements for a Pacific Basin concept.
 - 2) Storage: GSFLS storage element would include water basins, air cooled vaults, and geologic storage facilities. Supportive packaging facilities would be provided as required.

- 3) Recovery: Facilities designed to recover re-usable resources from spent fuel would be provided. Supportive waste management facilities would be provided as required.

Figure 2-3a depicts a GSFLS site layout.

- d) The technology underlying GSFLS building blocks are sufficiently well in hand or progressing through appropriate development programs to permit their implementation during the intermediate term.
 - 1) Transportation elements such as spent fuel casks, cask transporters and special nuclear fuel transport ships are already operational.
 - 2) Interim storage elements such as water basins are already operational.
 - 3) Long-term storage elements such as geologic facilities and air-cooled vaults are not operational at this time but have undergone considerable R&D and should be available by the mid to late 1980's.
 - 4) Reprocessing of LWR fuel using the Purex process is at the pilot plant or early commercial stage in several countries. Alternative energy resource recovery approaches are under intensive investigation within the U.S. at this time.

PBSFELS Transportation Requirements

- **CASKS:**

- 10 PWR OR 24 BWR ASSY.
- (4.6 MTHM CAPACITY)
- 85% UTILIZATION

- **SHIPS:**

- 3000 DWT
- DOUBLE HULLED
- LONGITUDINAL AND TRANSVERSE BULKHEADS
- REDUNDANT OPERATIONAL EQUIPMENT

- **TRANSPORTATION:**

- ABOUT 4000 STATUTE MILES
- AVERAGE SPEED 16 MPH
- ABOUT 1½ DAY TO TURNAROUND FOR SHIP

Figure 2-3

Figure 2-3a: Layout of Preferred Concept with Geologic Repository

2.5 GSFLS COSTS

Each GSFLS regional element would require billions of dollars of capital investment. Figure 2-4 compares the capital investment (\$1978 dollars) for a Pacific Basin and a European GSFLS concept. The principal cost differences for the two concepts are as follows:

- a) Transportation Costs: The Pacific Basin concept is based on 4000 miles of ocean travel (one-way average) and very short land travel; whereas the European concept is based on 1300 miles of ocean travel and approximately 500 miles (one-way average) land travel.
- b) Interim Storage Costs: The Pacific Basin concept is based on remote site construction costs and uses a construction cost escalation index of 1.5 whereas the European concept is based on a construction index of 1.0.
- c) Recovery and Waste Management: Construction cost escalation factors used for recovery and waste management facilities are as described above. The recovery plant for the Pacific Basin is slightly larger than the European concept (3700 MTHM/YR compared to 3400 MTHM/YR).
- d) Permanent Waste Storage: Both concepts assume permanent or long-term storage of waste in a relatively compacted form. The Pacific Basin concept assumes lack of geologic storage exists at the selected site and uses air-cooled vaults for long-term storage. The European concept is based on geologic storage.

Figure 2-5 shows the time-phased buildup of Project Fund Commitments for a Pacific Basin concept.

Figure 2-6 and 2-7 show the distribution of GSFLS income and user costs on a unit basis for services rendered during the Temporary Storage Phase - 1985 through 2000 (Figure 2-6) and the Spent Fuel Center Phase - Recovery occurs between years 2000 and 2030 (Figure 2-7).

	PACIFIC BASIN VAULT CONCEPT		EUROPEAN REGIONAL GEOLOGIC CONCEPT	
FUNCTION CAPITAL ITEM	ITEM TOTAL	FUNCTION TOTAL	ITEM TOTAL	FUNCTION TOTAL
TRANSPORTATION		.47 BILLION		.23 BILLION
SHIPS	0.13		0.07	
CASKS	0.22		0.13	
CASK MAINTENANCE	0.05		0.02	
CAPITALIZED INTEREST	0.07		0.01	
INTERIM STORAGE		1.56 BILLION		.95 BILLION
WATER BASINS	1.30		0.79	
SUPPORTING FACILITIES	0.01		0.01	
LOW LEVEL WASTE	0.09		0.06	
CAPITALIZED INTEREST	0.16		0.09	
RECOVERY & WASTE MANAGEMENT		3.97 BILLION		2.76 BILLION
RECOVERY	1.25		0.80	
HIGH LEVEL WASTE	1.35		0.84	
CAPITALIZED INTEREST	1.37		1.12	
PERMANENT WASTE STORAGE		.30 BILLION		.56 BILLION
PACKAGING	0.08		0.15	
VAULTS/GEOLOGIC REPOSITORY	0.22		0.41	
	6.30 BILLION		4.50 BILLION	

Figure 2-4: Summary of Capital Investment for GSFLS Concepts

Buildup of Total Project Funds Commitments

Figure 2-5

*ORIGINALLY PAID TO BUILDERS FROM EQUITY OR BORROWING AND RETURNED FROM EARNINGS

Figure 2-6: Disposition of GSFLS Income During Temporary Storage Phase (1935 through 2000)

* ORIGINALLY PAID TO BUILDERS FROM EQUITY OR BORROWING AND RETURNED FROM EARNINGS

Figure 2-7: Disposition of GSFLS Income During Spent Fuel Center Phase (2000 through 2030)

2.6 GSFLS ECONOMIC SENSITIVITIES

GSFLS economic sensitivities were performed around a baseline GSFLS using representative physical and financial characteristics. The baseline GSFLS used the following parameters:

<u>Parameter</u>	<u>Baseline Characteristics</u>
• System Configuration	• Water Basin buffer storage • Air-cooled vault long-term storage
• Resource Recovery	• Yr. 2000 start-up • 260 \$/KgHM recovery value
• Debt to Equity Ratio	2:1
• Return on Investment	20%
• Construction Site Cost Escalation Index	1.0
• Government Participation	Private enterprise

The following GSFLS economic sensitivities were determined;

<u>Variation of Baseline ROI</u>	<u>Service Charge</u> \$/KgHM
15%	70
20	180
25	270
30	360

Variation of Baseline
Start-Up of Recovery Operations

1990
2000
2010

Service Charge

190 \$/KgHM
180
200

Variation of Baseline
Construction Site Cost
Excalation Index

1.0
1.5
2.0
2.5

Service Charge

180 \$/KgHM
260
350
450

Variation of Baseline
Transportation Index

1000 miles
4000
8000
14000

Service Charge

130 \$/KgHM
140
160
180

Variation in Degree
of
Government Participation

Private Enterprise
Tax Free - Borrowing at
Government Rates
Government Operation

Service Charge

200 \$/KgHM
160
92

2.7 PACIFIC BASIN SPENT FUEL LOGISTICS SYSTEM (PBSFLS) INSTITUTIONAL FRAMEWORK

2.7.1 Institutional Concept

With the highest energy import dependence of any major industrial nation, Japan sees the breeder as an essential element in the development of a strategy to reduce this dependence. The accumulation of discharged spent fuel in the Pacific Basin with a fissile plutonium content in excess of 200 metric tons, enough to start up over 40 GWe of breeder reactors, may be an influencing factor for energy policies of the Basin countries, especially Japan. The predominance of Japanese spent fuel to the end of the century, in concert with the Japanese interest in National reprocessing, makes Japan the critical Western Pacific nation influencing a basin spent fuel arrangement. The participation of the remaining Western Pacific nations with spent fuel disposition requirements is of course very important.

The consideration of a Pacific Basin Spent Fuel Logistics System (PBSFLS) provides an opportunity for participants to assess reprocessing deferral decisions under conditions which might be responsive to their special interests and needs. With that understanding, the research effort has outlined assumptions on "key decisions and scenarios" for planning and analysis purposes.

The key scenario involves participant nations agreeing to place normal overflow spent fuel discharges from reactor plants in a "least cost" regional interim spent fuel storage facility with a commitment to deferral of early reprocessing. The capacity of the interim storage facility would accommodate cumulative spent fuel discharges through year 2000.

During the holding period from now to year 2000, the participant nations would agree upon nonproliferation and energy conservation criteria related to the balance of the fuel cycle and would make longer term spent fuel disposition decisions by the mid-1980's for implementation by year 2000 or other date as defined by criteria. The decision making by the mid-1980's would include three basin options, (1) to reprocess/recovery, (2) to continue surface storage, or (3) to dispose of spent fuel permanently.

The development of alternative concepts for a Pacific Basin spent fuel consortium incorporates four steps as follows: (1) Characterize the working environment of the future consortium by defining key nonproliferation, business operations, and financial strategy criteria; (2) identify candidate institutional models that proved to be successful, that will represent viable alternatives for a Pacific Basin arrangement, and will satisfy the three sets of criteria defined above; (3) identify preliminary organizational options that build upon the pertinent features of the candidate models; finally (4), propose an organizational architecture for the consortium that will satisfy all above considerations.

Three relevant organizational models were examined, EURATOM, URENCO, and Scandinavian Airlines System (SAS), resulting in two general organizational principals.

- a) Develop an organizational distinction between nonproliferation/regulatory and business operations functions, and
- b) Develop a distinction between national and multinational level participation.

As a result of the first general principle allowing for a distinction between nonproliferation/regulatory and business operations functions, Figure 2-8 presents the principal elements of the corporate structure of the consortium

according to well delineated responsibilities and functions. As shown in Figure 2-8, A government-to-government treaty would provide the basis and framework for launching and operating the consortium. Following the SAS and URENCO examples for setting the participation structure at the multinational corporate level, the Treaty would create a General Council (GC), an Audit and Control Bureau (ACB), a Board of Directors (BOD) and a Meeting of shareholders.

The Meeting of shareholders would be responsible for capital formation to meet the initial and on-going capital requirements as established by the Board of Directors. The Meeting of shareholders would elect the Board of Directors (BOD) and approve the annual report of activities.

Following SAS' participation rule, the voting power of the shareholders in the Meeting would be proportional to equity financing. For the Pacific Basin consortium, this principle implies an equal decision-making power between the sponsoring nations (based on their respectively equal equity financing participation), and a weighted decision-making power between sponsoring and cooperating nations, and among the cooperating nations themselves.

The General Council (GC) would be an independent regulatory head, representing the participating governments, with principal responsibilities in nonproliferation and safeguards policy and regulatory matters. The GC would provide direction in these areas to the Board of Directors. Following the organizational function of URENCO's Joint Committee, one of GS's roles would be to provide timely guidance to the otherwise autonomous venture management on commercial, production and other business policy matters that could give rise to problems of a political nature.

The Audit and Control Bureau (ACB) would be responsible for physical protection and material accountability

Corporate Organization of the Pacific Basin Consortium (PBC)

UNDERLYING PRINCIPLE: DISTINCTION BETWEEN NONPROLIFERATION/REGULATORY AND BUSINESS OPERATIONS FUNCTIONS

Figure 2-8

and control within the facility environs, and over material in transit. The ACB would also be responsible for both independent cost and nuclear materials auditing. It would report administratively to the GC. All information coming from the ACB, however, should be made available to both the GC and the BOD including its PBC management staff.

The Board of Directors (BOD) would be in charge of all the business operations of the consortium. In particular, the BOD will be in charge of defining corporate business policies, implementing health and safety standards, managing the internal operations of the group, and contracting work with external firms to the consortium. The BOD would be regulated by the GC for nonproliferation and safeguards matters.

The regulatory requirements of the host country would be coordinated by the GC and BOD as appropriate. The environmental, health and safety requirements of the host country would fall principally upon the BOD and the business operation.

At this point, the study assumptions regarding development of functional capabilities may be outlined. Three functional capabilities are envisaged for the PBSFLS:

- (1) facilities to conduct spent fuel storage and other fuel cycle activities as authorized, excluding permanent disposal,
- (2) facilities for permanent disposal of spent fuel or HLW, and
- (3) transportation capabilities.

The study assumptions are:

- a) The facilities for spent fuel storage and other fuel cycle activities, excluding permanent disposal, are the responsibilities of the PBSFLS

Organizational Architecture for a Pacific Basin Consortium Enterprise

UNDERLYING PRINCIPLE: DISTINCTION BETWEEN NATIONAL AND MULTINATIONAL LEVELS FOR CONCEPT FORMATION

Figure 2-9
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enterprise. It is more likely that the enterprise would develop these facilities as an internal operation rather than obtain contracted facilities services from an outside organization.

- b) The facilities for permanent disposal of spent fuel or HLW are the responsibility of the governments involved in the PBC and not of the PBSFLS enterprise.
- c) Spent fuel (and HLW) transportation services could be provided by transportation carriers under contract or by an internal organization of the PBSFLS enterprise. Shipping casks could be provided by either the enterprise, the reactor operators, or a contract carrier.

As a result of the second general principle allowing for a distinction between national and multinational levels, Figure 2-9 identifies three (i.e., subnational, national and multinational) levels of organization in the Pacific Basin consortium enterprise. At the subnational level, maximum flexibility would be allowed for private, public and private-public hybrid participation and concept formation as/if required.

At the national level, maximum flexibility would still be allowed for private, public and private-public hybrid concepts that constitute the national shareholders of the multinational consortium enterprise. One of the key functions of the national shareholders would be to reduce the number of participants into few major partners for consortium enterprise management. For the smaller cooperating nations (i.e., ROC, ROK, and the Philippines) an optional joint entity could be launched (at their request) to enhance their decision-making position at the corporate level of the consortium enterprise. Such a joint entity would then be in the same approximate position as one of the national shareholders of the sponsoring nations.

At the multinational level, participation would be fashioned after agreed upon guidelines and principles. One of such principles could specify that U.S.'s share in the consortium should equal the Japanese one, and that the sum of the shares of the smaller cooperating nations should not exceed that of the U.S. or Japan. Another principle could state that to have a sponsoring nation role, a minimum level of 30 percent equity financing will have to be reached by the (national or multinational) shareholder.

SAS provides a model of financing arrangements which might offer an interesting leverage treatment for the spent fuel accumulated by the consortium. Following this model, the spent fuel would be reported as assets in the multinational enterprise consolidated balance-sheet without renouncing national ownership and title to the spent fuel. The proposed mechanism would endow the PBSFLS enterprise with considerable financial leverage for funding possible energy recovery options in the late nineties, should this become economically attractive and politically acceptable. Such a prospect could possibly create a driving force cementing the national partners together to operate through the PBSFLS enterprise for developing balance of fuel cycle activities.

Possible site alternatives for a Pacific Basin spent fuel AFR facility include North America and the Western Pacific Islands. Japan has been screened out as a possibility at this stage of concept development because of Japanese views regarding the difficulty of storing foreign fuel. The siting objective includes the support of recovery and permanent disposal functions, as well as interim storage, although it is recognized that permanent disposal siting may be difficult. It is presumed that the project could be viable without permanent disposal co-located.

2.7.2 Institutional Development Plan

The GSFLS research would indicate that the institutional implementation of the Basin spent fuel storage consortium involves a two-phase program approach. The first phase would include a 1978-80 negotiation period to put the institutional cadre into place. At the end of the negotiation phase, the terms and principles of a government-to-government treaty (laid down by the U.S. and Japan, and later extended to other cooperating nations) should be agreed upon by all sponsoring and cooperating nations. Signature and ratification of the Treaty by the parties should be completed by 1981 at the latest. The second phase would support the technical development program to put the regional spent fuel logistical system into operation by 1985-86.

The institutional development plan (see Figure 2-10) includes three basic activity areas that have to be performed in parallel to complete treaty negotiations by the 1980 milestone. Activity 1 (see Figure 2-11) defines the basis for agreement and drafts the Treaty. Activity 1 is responsible for (1) defining the framework (i.e., guidelines, principles, and policy options) for the other two Activities, and (2) managing, controlling, and integrating the outputs of the latter over the phase 1 period to prepare and complete a draft-form treaty by 1980.

Activity 2 (see Figure 2-12) develops control and siting regimes for Activity 1 under the guidance of the latter. Activity 2 has a twofold responsibility: (1) design the multinational control system to be put into place for the Pacific Basin consortium, and (2) identify the siting regime and attendant regulatory options linked with site selection and consortium operations concerning environmental, health, and safety aspects.

Activity 3 (see Figure 2-13) develops the national and multinational enterprises for Activity 1 under the guidance of the latter. Activity 3 has a threefold responsibility (which can be performed jointly (i.e., U.S. - Japan) or separately according to activity areas): (1) define the organization of national (U.S., Japanese) enterprises and launch the two enterprises for consortium formation, (2) define organization and participation structure for the multinational consortium, and (3) develop an ad hoc contracting capability (for the 1980-81 period) that would bind the consortium. This contracting capability would function as a safety valve in case of program slippage beyond the 1980 milestone that would impact on the phase 2 program.

Institutional Development Plan

Figure 2-10

Define Basis of Agreement and Draft Treaty

ACTIVITY 1

Figure 2-11

Develop Control and Siting Regimes

ACTIVITY 2

PROGRAMMATIC STEPS FOR TREATY IMPLEMENTATION

Figure 2-12

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Develop National and Multinational Enterprise Concepts

ACTIVITY 3

INPUTS OF
DOE/DEPT. OF STATE
INITIATIVE STATEMENT
(RESULTS OF STEP 1/
ACTIVITY 1)

STEP 2

PRIVATE SECTOR
PARTICIPATION TO
CONCEPT FORMATION

STEP 3

BILATERAL OR
NATIONAL CONSENSUS
ON ENTERPRISE
CONCEPTS

WITH ACTIVITY 2

STEP 4

MULTINATIONAL
CONSULTATION FOR
CONSORTIUM
FORMATION AND
LEGAL ACTION FOR
NATIONAL CONCEPTS

STEP 5

IMPLEMENTATION OF
NATIONAL (AND OTHER
FOUNDING) ENTERPRISES
AND DOCUMENT
FOR TREATY DRAFT

WORKING GROUPS/WORK BREAKDOWN

MULTINATIONAL ENTERPRISE
WORKING GROUP:

- FORMATION OPTIONS
- RELATIONS WITH NATIONAL ENTERPRISES
- CORPORATE STRUCTURE, ROLES AND FUNCTIONS
- OWNERSHIP STRUCTURE
- FINANCING
- IMPLEMENTATION

U.S. NATIONAL ENTERPRISES WORKING GROUP:

- FORMATION OPTIONS
- CHOICE OF LEAD COMPANY
- PARTICIPATION STRUCTURE
- ENABLING LEGISLATION (AS/IF REQUIRED)
- FINANCING
- IMPLEMENTATION

JAPANESE NATIONAL ENTERPRISE WORKING GROUP:

- FORMATION OPTIONS
- CHOICE OF LEAD COMPANY (IF ANY)
- PARTICIPATION STRUCTURE
- LEGAL/REGULATORY ASPECTS
- FINANCING
- IMPLEMENTATION

U.S./JAPANESE COMMISSION FOR AD HOC CONTRACTING CAPABILITY:

- AUTHORITY TO COMMIT
- CONDITIONS FOR COMMITMENT
- FINANCIAL RESOURCES
- BINDING SITUATION FOR PBC

○ PRELIMINARY DOCUMENT

OR

ITERATIVE PROCESS
△ DECISION IN PRINCIPLE

▲ FINAL DECISION
◉ INTERIM DOCUMENT

● FINAL DOCUMENT

◊ LAUNCHING OF ENTERPRISE, OR AD HOC CONTRACTING CAPABILITY

Figure 2-13

2.8 EUROPEAN GSFLS INSTITUTIONAL FRAMEWORK

The institutional aspects of a European spent fuel arrangement are significantly different from the Pacific Basin. In Europe, there are many differing national interests involved which rule out simple approaches. The major constraints to implementing any nonproliferation arrangement in Europe are fivefold:

- (1) From a spent fuel disposition standpoint, a multinational AFR storage initiative does not offer a viable alternative to early reprocessing if not linked to a permanent disposal commitment for the forecasted unreprocessed spent fuel flows.
- (2) Commercial LWR reprocessing is extant, and present capacity will eventually be expanded to accommodate near term international market needs.
- (3) Six European nations are on the critical path to any nonproliferation strategy: France, Germany, the U.K. and Belgium for the near term, and Spain and Italy for the intermediate term. All six nations are, with various degrees of commitment, on the national reprocessing path.
- (4) European nations have distinct views about the residual energy value of spent fuel, and therefore have different reprocessing rationales.
- (5) The breeder development program appears successful, and FBRs could be ready for deployment in France and Germany in the intermediate term.

Considering the above constraints, the following key nonproliferation considerations applicable to spent fuel facilities in Europe are, with decreasing importance:

- (1) Reduction of incentives for national fuel cycle activities, including national reprocessing.
- (2) Implementation of a bridge vehicle allowing for time to develop permanent disposal solutions and relieve pressure for premature fuel movements into reprocessing options.
- (3) Unwanted technology transfers.
- (4) Nationalization of multinational spent fuel facilities by host country.
- (5) Possible deemphasis of proliferation concerns and safeguards.
- (6) Host country cessation or slowdown of fuel cycle functions.

The delineation of key constraints and nonproliferation considerations for shaping a European spent fuel arrangement concludes that:

- (1) As the nonproliferation considerations are singled out for implementation, the geographic base of the nonproliferation arrangement could decrease significantly. Conversely, addressing all the nonproliferation considerations would involve the recognition of near term commercial reprocessing interests in Europe.

- (2) Nonproliferation considerations cannot be addressed if concepts for European arrangements do not center on the reprocessing and permanent disposal issue at the outset. Only then, can an AFR capability be accepted as a means to reduce the pressure to prematurely reprocess as a means of spent fuel disposition.
- (3) The recognition of near term commercial reprocessing interests in Europe would recommend a nonproliferation arrangement building on existing institutions first. This approach failing, recourse to developing new institutions would then be warranted.

U.S. Policy calls for the deferral of commercial reprocessing until a new international consensus is reached on technical and institutional measures which will allow energy recovery from spent fuel to go forward under acceptable nonproliferation conditions. In attempting to give maximum effect to this policy under the complex conditions prevailing in Europe, the study concludes that the most promising approach is to seek to bring existing reprocessing programs into a framework which results from mutually agreed upon - by the U.S. and the European countries - nonproliferation conditions which they would apply. The alternative to this might well be arrangements which lead to greater restrictions on the reprocessing of limited amounts of spent fuel, while allowing large amounts of fuel to be reprocessed under inadequate nonproliferation conditions. Thus, the recommended approach places greater emphasis on that aspect of U.S. policy which

calls for international agreement on improved nonproliferation conditions, both technical and institutional, and relatively less emphasis on deferral for deferral's sake alone.

The study addresses the spent fuel storage issue. The development of acceptable spent fuel arrangements in Europe requires, however, that permanent storage and reprocessing be considered at the outset. Spent fuel disposition alternatives could provide a basis to negotiate multinational nonproliferation arrangements with existing national reprocessing interests. These alternatives provide strengthened rationale to influence national reprocessors on nonproliferation criteria and at the same time offer nations served an acceptable spent fuel disposition service if needed.

As a result, two approaches can be envisioned for a nonproliferation arrangement. The first approach is to build exclusively on existing European and U.S. institutions, providing U.S. support and obtaining a mechanism for U.S. voice in European reprocessing criteria and decisions. The second approach would develop multinational spent fuel logistics operations in Europe which would offer storage and associated fuel cycle service reflecting nonproliferation concerns not accepted by existing reprocessing institutions. The second approach would come in place if the first could not be implemented.

2.8.1 Approach #1: Building on Existing Institutions

The assumption in this approach is the recognition of the present URG organization, capabilities and contracts. The

principle elements of this approach are as follow:

- (1) A mechanism would be established, such as a "General Council" organization, to develop and implement nonproliferation policy regarding spent fuel interim storage, reprocessing and permanent storage, and Pu utilization. The nonproliferation policy would include criteria for a spent fuel release mechanism covering energy resource conservation requirements and appropriate technical and institutional matters related to the release mechanism. The timing and the technical and institutional factors associated with reprocessing and Pu utilization would be defined. The criteria for extending technology transfer in sensitive areas would be defined. The membership of the General Council would include government representatives of the U.S., U.K., France, F.R.G., Belgium, and countries offering permanent storage alternatives. The nonproliferation policy and practices established would have to be acceptable to all founders.
- (2) The U.S. would allow business as usual conditions to prevail for the URG and Belgian reprocessing. However, such operations would proceed under the nonproliferation policies of the General Council.

BNFL and COGEMA would perform load balancing between them as they see fit. Belgium would integrate into the URG structure. F.R.G. would service Austria and Luxembourg as they see fit.

- (3) The U.S. would provide a back-up for permanent storage. European reprocessing countries would make best efforts to develop permanent storage. The U.S. would directly offer permanent storage to those countries not committed to reprocessing.
- (4) Barnwell would be offered as a back-up reprocessor if required by the European and U.S. markets. This could be done as an extension of the URG structure, appropriately enhanced.
- (5) Expansion of European fuel cycle centers would be supported as approved by the General Council. The General Council would be expanded to include government representatives of additional fuel cycle center countries. The U.S. would provide initiatives if appropriate to develop an additional multinational fuel cycle center serving Mediterranean countries. In effect, this operation would organize as an extension of the URG structure.

- (6) The approach recognizes the possibility of a Swedish AFR, however, the assumption is that the Nordic fuel would go to BNFL/COGEMA.

2.8.2 Alternate Approach #2: Develop New Institutions

In the event that the Approach #1 is unsuccessful, the assumption is that the U.S. would act to stimulate multinational centers which would offer European spent fuel disposition services. The reference case assumes most nations, except URG countries, would be responsive to a European arrangement and work toward a single fuel center in the Mediterranean. There are two modifications, one in which the Northern Europe countries separate from the Mediterranean Center and one in which the Mediterranean Center does not develop and fuel flows to centers in either Sweden or Belgium and the U.S. Formation options for Approach #2 are shown in Figure 2-14.

Reference Case

- (1) Japanese fuel is positioned for the Pacific Basin consortium.
- (2) The U.S. stimulates the interest for a Mediterranean center to serve as a fuel center host for the non-URG European countries, including Belgium. The Mediterranean center offers to provide permanent storage services associated

FIGURE 2-14
FORMATION OPTIONS
FOR THE APPROACH #2

with the fuel center in return for financial support from European countries. A mechanism would be established such as a "Commission" to develop and implement nonproliferation policy regarding spent fuel interim storage, reprocessing and permanent storage, and Pu utilization. The nonproliferation policy would include criteria for a spent fuel release mechanism covering energy resource conservation requirements and appropriate technical and institutional matters related to the release mechanism. The timing and the technical and institutional factors associated with reprocessing and Pu utilization would be defined. The criteria for extending technology transfer in sensitive areas would be defined. The nonproliferation policy and practices established would have to be acceptable to all founders. The contractual foundation approach for this concept is shown in Figure 2-15.

- (3) The financial participation would include the U.S. and the European countries being served.
- (4) The U.S. would provide a back-up for permanent storage. The Mediterranean center would make

FIGURE 2-15

CONTRACTUAL FORMATION APPROACH

its best efforts to develop permanent storage.
The U.S. would directly offer permanent storage
to those countries not committed to reprocessing.

- (5) Barnwell would be offered as a back-up
reprocessor if required by the European and
U.S. markets.
- (6) The approach would recognize the possibilities
of Belgian reprocessing and of a Swedish AFR;
however, the assumption of the reference
case is that neither would operate and that no
additional European centers would be newly
developed.

Modification #1, Northern Countries Separate from Mediterranean
Center.

- (1) In the event that the sense of this approach
is accepted by the non-URG European countries,
but that the Northern countries prefer to limit
their involvement in a Mediterranean Center,
the reference case is modified to include a
Northern Europe Fuel Center located in either
Sweden or Belgium. The Nordic Council countries
plus Netherlands and Belgium would send fuel
to that center. The Mediterranean Center would
serve Switzerland, Austria, Italy and Spain.

- (2) The Commission of the reference case would extend separately or as a joint function of the Northern Europe and the Mediterranean centers, the joint function being preferred.
- (3) The Mediterranean center would offer and make best efforts for permanent storage services to both centers. The U.S. would provide a back-up for permanent storage and directly offer permanent storage to those countries not committed to reprocessing.
- (4) Financial participation in the Mediterranean center would include the U.S. and the countries served. In addition, the northern countries would compensate the Mediterranean center for permanent storage services only.
- (5) The Belgian reprocessing center would not operate if Sweden were the Northern Europe host nation and there would be no additional European centers newly developed.
- (6) Barnwell would be offered as a back-up reprocessor if required by the European and U.S. markets.

Other elements as in Reference Case.

Modification #2, Mediterranean No-Go

- (1) In the event that the sense of this approach is accepted by the non-URG European countries, but that the Mediterranean center is not a possibility, the Northern Europe center as identified in Modification #1 is expanded to include Switzerland and Austria. The Mediterranean Center countries of Modification #1, less Switzerland and Austria, form a multinational arrangement with the U.S. as host country.
- (2) In this modification, the U.S. would support the Northern Europe center financially.
- (3) The U.S. host country center would be financed by the U.S. and the countries served.
- (4) The Northern Europe center host country would make best efforts to accommodate permanent storage.

Other elements as in Modification #1.

3.0 GSFLS STUDY CONCLUSIONS

3.1 GENERAL CONCLUSIONS

- (1) The intermediate term (1983 to 2000) represents a period of major need for global spent fuel logistics systems.
- (2) There is a wide spectrum of attitudes and approaches guiding various national spent fuel disposition strategies. However, the principal forcing functions include (a) at-reactor storage pressures (b) perceptions of fuel cycle economics; (c) plans and maturity of plutonium breeder involvements; (d) concerns and constraints with respect to nuclear waste management; (e) non-proliferation concerns and attitudes and (f) availability of alternative spent fuel disposition supply capabilities.
- (3) The intermediate term represents a period of opportunity for implementing GSFLS that can satisfy global needs.
 - a) Several regionally or globally oriented systems serving multiple countries - as opposed to many national systems serving only national needs - could be implemented during the intermediate term.
 - b) Nonproliferation objectives could be served by implementing GSFLS that can provide interim storage of spent fuel and defer plutonium reprocessing until the proliferation risks are viewed by nations to be at acceptable levels.

- c) A plausible GSFLS "scenario" would be to establish regional or global systems that could start-up AFR storage programs by 1985 $\pm$ 2 years; accommodate approximately 20,000 MTHM cumulative spent fuel shipments to a regional center by year 2000; and provide energy recovery after an appropriate deferral period commensurate with resolving nonproliferation concerns.
- d) The technology underlying GSFLS building blocks are sufficiently well in hand or progressing through appropriate development programs to permit their implementation during the intermediate term.
- e) Each regional GSFLS would require billions of dollars of capital investment. There are adequate sources to finance a GSFLS project provided an appropriate credit support structure can be established. Financing for major GSFLS facilities (e.g., large interim storage and/or recovery facilities) will likely be financed at the project level as opposed to the participant level and will likely require governmental guarantees from participating countries.
- f) A sensitivity analysis of GSFLS economics shows that the net charge to utilities for GSFLS services can vary widely.
- g) A variation in start-up of resource recovery operations (i.e., "deferral period") within the 1990 to 2010 time frame will not appreciably affect GSFLS service charges to utilities.
- h) Institutional factors represent the major hurdles for implementing GSFLS.

- o Political consensus regarding non proliferation objectives and approaches must be developed.
- o Siting constraints must be resolved. These constraints include political acceptability of host country; legal/regulatory requirements associated with a specific project and site; and acceptance of a siting proposition by local and national population.
- o Appropriate GSFLS organizational architecture must be established. The organizational architecture must provide for global non-proliferation controls; accommodate possible bi-lateral or multinational participation; and allow for efficient day-to-day project operations.

- (1) Japan is the critical Western Pacific nation influencing a Pacific Basin spent fuel arrangement. The predominance of Japanese spent fuel to the end of the century coupled with Japan's interest in national reprocessing are critical factors in overall Pacific Basin spent fuel logistics considerations.
- (2) Japan views commercial "breeder" deployment as a major objective of its energy policies. With the highest energy input dependence of any major individual nation, Japan is placing great emphasis on the implementation of a "breeder" economy. The accumulation of discharged spent fuel in the Pacific Basin with a fissile plutonium content in excess of 200 metric tons, enough to start up over 40 GWe of breeder reactors, may be an influencing factor for energy policies of the Basin countries, especially Japan.
- (3) The consideration of a Pacific Basin Spent Fuel Logistics System (PBSFLS) provides an opportunity for participants to assess reprocessing deferral decisions under conditions which might be responsive to their special interests and needs.
- (4) A Pacific Basin arrangement should seek agreement to place normal overflow spent fuel discharges from reactor plants in a "least cost" regional interim spent fuel storage facility with a commitment to deferral of early reprocessing. The capacity of the interim storage facility would accommodate cumulative spent fuel discharges through year 2000.

(5) A holding period should be established by the arrangement.

- During the holding period (from now to year 2000) the participant nations would agree upon nonproliferation and energy conservation criteria related to the balance of the fuel cycle and would make longer term spent fuel disposition decisions by the mid-1980's for implementation by year 2000 or other date as defined by criteria. The decision making by the mid-1980's would include three basic options, (1) to reprocess/recover, (2) to continue surface storage, or (3) to dispose of spent fuel permanently.
- The arrangement should provide U.S. assurances that (1) no possible nuclear fuel options will be foreclosed at any time in the future, and (2) agreed upon flexibility in spent fuel release will be guaranteed.

(6) The development of alternative concepts for a Pacific Basin spent fuel consortium recommends two general organizational principles:

- Develop an organizational distinction between nonproliferation/regulatory and business operations functions, and
- Develop a distinction between national and multinational level participation.

(7) Possible site alternatives for a PBSFLS include North America and the Western Pacific Islands.

Japan has been screened out as a possibility at this stage of concept development because of Japanese views regarding the difficulty of storing foreign fuel. The siting objective includes the support of

recovery and permanent disposal functions, as well as interim storage, although it is recognized that geologic disposal siting may be difficult and long-term storage could be provided by air-cooled vaults. It is presumed that the project could be viable without co-located permanent disposal.

(8) The principal hardware and facility requirements for a PBSFLS by the year 2000 are as follows:

- a) 71 spent fuel casks (4.6 MTHM each)
- b) 14 spent fuel transport ships (3000 DWT) each capable of handling 4 casks.
- c) A four port receiving basin; and 19 water basins (1025 MTHM each)
- d) A 3700 MTHM/YR recovery plant and supporting waste management facilities.
- e) An air-cooled vault and supporting packaging facilities.

(9) The total capital investment required for a PBSFLS concept is 6.30* billion dollars and includes the following functional breakdown:

Transportation	\$.47 billion
Interim Storage	1.56
Recovery and Waste Management	3.97
Packaging and Air-cooled Vaults	.30

The capital investment program would be phased-in over a 45 year period with the majority being expended between 1985 and 2000.

*Includes cost escalation factor of 1.5 to account for remote site construction effects.

(10) The pricing of PBSFSL services is as follows:

Transportation	22 \$/Kg HM
Interim Storage	197
Recovery	338
Air-cooled Vault Storage and Handling	20

(11) Implementation of a PBSFSL requires proceeding with a Program Formulation Phase and accomplishing its objectives by 1980. The objectives of the Program Formulation Phase are as follows:

- a) An institutional development program would define the basis of agreement and draft appropriate treaties; develop control and siting regimes; and develop national and multinational enterprise concepts.
- b) A technical development program would support site selection, preliminary facility design and licensing activities.

- (1) The institutional aspects of a European spent fuel arrangement are significantly different from the Pacific Basin. Europe reflects many differing national interests which rule out simple approaches. Commercial reprocessing is extant and expanding with as many as six nations having various degrees of commitment to the national reprocessing path, and having differing reprocessing rationales.
- (2) European countries can be categorized into three groups reflecting major national concerns relevant to spent fuel disposition decision making. These groups are as follows:
 - a) Waste Management Oriented Group including Austria, Finland, Denmark, Luxembourg, Netherlands, Norway, Sweden, and Switzerland.
 - b) National Reprocessing-Oriented Group including Belgium, Italy, Spain and the United Kingdom.
 - c) Breeder Deployment-Oriented Group including France and the Federal Republic of Germany (FRG).
- (3) Nonproliferation considerations cannot be addressed if concepts for European arrangements do not center on the reprocessing and permanent disposal issue at the outset. Only then, can an AFR storage capability be accepted as a means to reduce the pressure to prematurely reprocess as a means of spent fuel disposition.
- (4) Spent fuel disposition alternatives could provide a basis to negotiate multinational nonproliferation arrangements with existing national reprocessing interests. These alternatives would provide

strengthened rationale to influence national reprocessors on nonproliferation criteria and at the same time offer nations served an acceptable spent fuel disposition service if needed.

- (5) The recognition of near term commercial reprocessing interests in Europe would recommend building a nonproliferation arrangement on existing institutions first. This approach failing, recourse to developing new institutions would then be warranted.

- a) The most promising approach is to seek to bring existing reprocessing programs into a framework which results from mutually agreed upon - by the U.S. and the European countries - nonproliferation conditions. Thus, the recommended approach places greater emphasis on that aspect of U.S. policy which calls for international agreement on improved nonproliferation conditions, both technical and institutional, and relatively less emphasis on deferral for deferral's sake alone.
- b) A second approach would develop multinational spent fuel logistics operations in Europe which would offer storage and associated fuel cycle service reflecting nonproliferation concerns not accepted by existing reprocessing institutions. The second approach would come in place if the first could not be implemented.

- (6) The principal hardware and facility requirements for a European Regional Spent Fuel Logistics System (ERSFLS) by the year 2000 are as follows:

- a) 29 spent fuel casks (4.6 MTHM each)
- b) 5 spent fuel transport ships (3000 DWT) each capable of handling 4 casks.

- c) A four port receiving basin; and 17 water basins (1025 MTHM each)
- d) A 3400 MTHM/YR recovery plant and supporting waste management facilities.
- e) A geologic repository and supporting packaging facilities.

- (7) The total capital investment required for an ERSFLS concept is 4.5 billion dollars and includes the following functional breakdown:

Transportation	.23 Billion
Interim Storage	.95
Recovery and Waste Management	2.76
Packaging and Geologic Repository	.56

The capital investment program would be phased-in over a 45 year period with the majority being expended between 1985 and 2000.

- (8) The pricing of ERSFLS services is as follows:

Transportation	21 \$/Kg HM
Interim Storage	139
Recovery	262
Geologic Storage and Handling	22

4.0 GSFLS STUDY RECOMMENDATIONS

The GSFLS study has developed a preliminary framework for conceptualizing and implementing selected regionally oriented spent fuel logistics systems. In order to improve on the validity of the ideas and concepts established to date; and to allow positive movement towards a successful resolution of an area that has generated considerable global controversy, it is recommended that the following actions be taken:

- (1) The nature and substance of the GSFLS study be examined and refined within the International Nuclear Fuel Cycle Evaluation (INFCE) process.
- (2) The Program Formulation activities described for the Pacific Basin Spent Fuel Logistics System (see Part II, Section 4) be initiated.

1.0 INTRODUCTION

Part I of this report summarizes the GSFLS study's perception of a global spent fuel logistics framework. The scope of this framework is delineated by the following study "ground-rules":

- Spent fuel logistics systems serving multiple countries, as opposed to national systems, were considered to be the elements of a global spent fuel logistics framework. This ground rule was selected on the basis of having the best potential for serving global non-proliferation objectives and offering more attractive economics.¹⁾
- All spent fuel logistics systems would have the capability to sustain a "deferred" energy recovery scenario. This ground rule was selected in deference to the current uncertainties associated with plutonium reprocessing.
- The nuclear reactor population under consideration included only Light Water Reactors (LWR). It was further considered, for the purposes of the study, that LWR's would be added only until the year 2000 although spent fuel from the LWR population would be generated until the year 2030.

The GSFLS framework is described in terms of its principal components, namely:

1) Regional Nuclear Fuel Cycle Centers: 1977 Report of The IAEA Study Project

GSFLS Institutional Framework (Section 2)

Summary description of country related GSFLS characteristics; GSFLS rationale; and global spent fuel profiles that influence strategies leading to the formation of a GSFLS framework.

GSFLS Technical/Financial Framework (Section 3)

Summary description of the technical systems and resulting economic/financial implications associated with perceived GSFLS.

GSFLS Legal/Regulatory Framework (Section 4)

Summary description of the legal/regulatory issues and their relevance to the planning and formation of GSFLS.

GSFLS Siting Considerations (Section 5)

A synopsis of GSFLS siting considerations.

2.0 GSFLS INSTITUTIONAL FRAMEWORK

2.1 INTRODUCTION

GSFLS alternative proposals to support nonproliferation objectives must result in compatible solutions for the energy planning and program structure of participating nations. Without this accommodation, the GSFLS strategies would appear to have small chance of success. The packaging of GSFLS strategies must depend upon a mutual sharing of the strengths, weaknesses and vital interests of participants in technical, political and economic areas; and will likely require some degree of national compromises in the interest of global harmony.

In structuring a GSFLS institutional framework, the following areas are considered:

- U.S. Policies on spent fuel disposition. (Section 2.2)
- Rationale for GSFLS Strategies. (Section 2.3)
- Country related GSFLS characteristics. (Section 2.4)
- Global spent fuel profiles. (Section 2.5)

Institutional strategies and concepts for a Pacific Basin and European spent fuel logistics system based on the framework established in this section are provided in Parts II and III, respectively, of this report.

2.2 U.S. POLICIES ON SPENT FUEL DISPOSITION

United States policy on spent fuel disposition - both domestic and foreign - is an integral and important part of U.S. nonproliferation policy. Its fundamental premise derives from President Carter's nonproliferation policy statement of April 7, 1977, the first point of which stated:

"We will defer indefinitely commercial reprocessing and recycling of the plutonium produced in the U.S. nuclear power program. From our own experience we have concluded that a viable and economical nuclear power program can be sustained without such reprocessing and recycling."

While this statement was, of necessity, applicable only to the U.S. nuclear power program, the President made it clear that he hoped other nations would adopt similar policies.

The policy of indefinite deferral of commercial reprocessing in turn gives rise to a number of important consequential policies affecting spent fuel disposition. These include:

- (1) As announced by the Department of Energy on October 18, 1977, the U.S. Government plans to take title to and store all spent fuel from those U.S. utilities wishing to participate, on payment of a one-time storage fee. The policy provides that the spent fuel could be returned to its original owner or compensation given for its net fuel value if and when reprocessing is ever deemed appropriate.

- (2) Foreign nations have been encouraged to defer commercial reprocessing and, through the International Nuclear Fuel Cycle Evaluation (INFCE) have been brought together in a cooperative effort to evaluate alternate proliferation-resistant fuel cycles and institutional arrangements.
- (3) The U.S. has adopted a restrictive policy on the reprocessing of U.S. supplied spent fuel abroad over which it exercises reprocessing approval rights, extending such approval only when there is an operational necessity for removal of spent fuel from reactor cooling ponds and when the parties agree that the resultant plutonium will be retained at the reprocessing plant site unless U.S. approval is granted for an alternate disposition.
- (4) The U.S. has indicated, in its October 18, 1977 spent fuel policy announcement, its intention "in support of its nonproliferation goals, to extend the offer [of storage in the U.S.] to foreign users on a limited basis [emphasis added]."
- (5) As a corollary to the foregoing policies on disposition of foreign spent fuel of U.S. origin, "the U.S. is encouraging nations to expand their own storage capacity and is strongly supporting the study of regional or international storage sites." This support has taken the form, among

other actions, of this study of Global Spent Fuel Logistics Systems and of U.S. participation as a principal contributor to the IAEA study on a possible IAEA spent fuel storage activity.

The policies set forth above are supported and to some extent qualified by both relevant legislation and bilateral and international agreements. The Nuclear Non-Proliferation Act of 1978, signed by President Carter on March 10, 1978 contains several provisions which relate to foreign spent fuel disposition. These include:

- Section 104 (a)(4) and (5) which calls on the President to seek to negotiate "the establishment of repositories for the storage of spent nuclear reactor fuel under effective international auspices and inspection" and "arrangements under which nations placing spent fuel in such repositories would receive appropriate compensation for the energy content of such spent fuel if recovery of such energy content is deemed necessary or desirable."
- Section 403(b) which calls on the President to seek agreement of other suppliers on an export policy under which no spent fuel will be reprocessed "except in a facility under effective international auspices and inspection" and "any such irradiated fuel elements shall be transferred to

such a facility as soon as practicable after removal from a reactor consistent with safety requirements." (While this provision appears to encourage the early establishment of reprocessing facilities under international auspices, it seems more likely that the Congressional intent was to encourage early removal of spent fuel from the countries in which it was generated to a limited number of storage facilities, rather than to facilities where reprocessing would occur promptly).

-- Section 131(f), which requires that any arrangement for the storage or disposition of foreign spent fuel in the United States be subject to Congressional review and veto by concurrent resolution. An exception to this review and veto provision is made for the storage of limited amounts of foreign spent fuel when the President determines that there is an emergency situation requiring U.S. storage.

-- Section 401(a)(7) which requires that new agreements for cooperation contain a broadened right of U.S. approval over spent fuel reprocessing, which will extend not only to fuel of U.S. origin, as in most present agreements, but also to any fuel irradiated in U.S. supplied reactors. (As in the case of other new requirements for agreements for cooperation, the President may waive this requirement, subject to Congressional review and veto).

In addition to the provisions cited above which are directly applicable to spent fuel disposition, the new legislation contains provisions which specify the criteria which the U.S. will apply when considering requests of other governments for U.S. approval to reprocess spent fuel of U.S. origin. Section 303(a) requires that U.S. approval for reprocessing cannot be given unless there is a U.S. determination that the reprocessing will not result in a significant increase of the risk of proliferation. In making this determination, "foremost consideration" must be given to whether or not there will be "timely warning" of any diversion well in advance of the time by which diverted material could be transformed into a nuclear explosive. While there are exceptions made to the use of this criterion in the case of existing reprocessing facilities, the restrictive nature of the criterion reinforces current Executive Branch policy and has the effect of a greater accumulation of spent fuel than would be the case if U.S. reprocessing approval were granted on the more permissive basis of the past.

Existing U.S. bilateral agreements also affect spent fuel disposition policies and actions, since these agreements provide the contractual basis on which U.S. approval of reprocessing or other spent fuel disposition may be necessary. In general, U.S. bilateral agreements give the U.S. the right, qualified in most instances by the criterion of whether safeguards can be effectively applied, to approve of any reprocessing of U.S. supplied material. As observed earlier,

this approval right is to be expanded in new agreements to include any fuel material, regardless of origin, irradiated in U.S. supplied reactors. Under Section 404(a) of the new legislation, the U.S. is required to initiate a program of renegotiation of existing agreements to seek to incorporate this and other new provisions. Agreements which contain U.S. rights of approval over reprocessing also customarily include a U.S. right to approve the storage facilities employed by the recipient country for any U.S. supplied material not required in the country's program, a provision which clearly includes spent fuel.

While provisions along the lines indicated above are present in most U.S. agreements, there are three exceptions. These are the agreements with EURATOM, the IAEA and Canada, under which the U.S. retained no right to approve reprocessing even of U.S. supplied fuel. The absence of this provision in the agreement with Canada is of academic importance only, since the U.S. is not a supplier of power reactor fuel to Canada and current Canadian policy would enable Canada to agree to such a requirement if/when the U.S.-Canadian agreement is renegotiated. It is expected that the agreement with the IAEA will be renegotiated to include U.S. reprocessing approval rights in subsequent fuel supply arrangements through the IAEA, but this understanding will not necessarily be retroactive to the existing U.S.-IAEA supply arrangements.

The Agreement for Cooperation with EURATOM, under which a significant portion of U.S. nuclear fuel exports takes place, contains no provision for U.S. approval over reprocessing, and EURATOM has so far not informed the U.S. of its willingness to enter into renegotiations of this Agreement. As a consequence, U.S. nuclear exports to the Community have been suspended pursuant to Section 304 of the new legislation.

2.3 RATIONALE FOR GSFLS STRATEGIES

The conduct of the study requires a generic definition of spent fuel policy objectives as they would apply to specific world regions and countries. An estimate of these objectives has been developed to support the assessment of GSFLS strategies.

The study assumes a generic policy with respect to the disposition of spent fuel to be an integral part of a policy directed toward the deferral of reprocessing and the consequent accumulation and dispersion of weapons-useable plutonium, until the proliferation risks are viewed by nations to be at acceptable levels. While spent nuclear fuel from present day light water or heavy water reactors is not a weapons-useable material, it represents a proliferation risk in two respects:

- The accumulation of spent fuel, especially in sensitive countries or regions, constitutes a source of plutonium if and when a country in which it is located decides upon and achieves a reprocessing capability, and the ready availability of spent fuel may even stimulate a decision to engage in reprocessing for military reasons.
- In some countries, the long term storage of spent fuel is viewed as unacceptable, creating pressures for reprocessing as a means of alleviating the storage problem, with the consequent production of weapons-useable plutonium.

These two considerations could imply significantly different policy objectives, with correspondingly different solutions. To the extent that spent fuel is regarded as a proliferation hazard per se, the indicated objective would be to encourage or require the removal from national control of the maximum possible amount of spent fuel. To the extent that spent fuel is regarded with concern only when it provides the rationale

or motivation to engage in reprocessing, the corresponding objective would be to offer concerned countries an alternative to the national accumulation and storage of spent fuel to the extent that such material would otherwise be reprocessed. A considerably less aggressive policy might satisfy this objective than that required to offer positive encouragement to the transfer of spent fuel inventories.

These two objectives are not, however, mutually exclusive. For example, the second objective may be regarded as the universal minimum, with the first objective a desirable collateral goal, especially with respect to countries deemed to represent especially serious proliferation risks. Policy-makers may, accordingly, view both of these objectives as desirable, attaching more or less weight to one than the other. On the other hand, policies designed to accomplish the second objective may be incompatible with, or fall short of, those needed to satisfy the first objective. This raises the question of whether implementing policies must necessarily be uniform, or whether differing arrangements for different countries and regions can be considered.

The study assumes the generic policy objective is to offer a viable storage scheme for those nations which protest that reprocessing will otherwise be necessary, rather than to draw as much fuel as possible from national control abroad. A factor supportive of this conclusion is that substantial plutonium inventories are inevitably present in operating reactors, as well as in spent fuel not yet sufficiently cooled for transfer from a reactor site. In light of these inventories, even a very aggressive policy of spent fuel removal cannot deprive nations with even a small nuclear power program of significant stocks of unseparated plutonium should they choose to violate or abrogate international undertakings.

A policy of deferral of reprocessing is vulnerable to the criticism that it creates what, for a number of countries,

is an unacceptable requirement for the long term storage of spent fuel, unless a credible alternative means of disposing of spent fuel can be offered. This is especially true where the United States is able, through the exercise of its reprocessing approval rights, to forestall a reprocessing option. The viability of United States policy for deferral of reprocessing may, therefore, depend heavily on the ability of the United States to offer, or at least to be instrumental in the development of, acceptable spent fuel disposition alternatives.

The exploration of possible multinational or international options for spent fuel storage, especially under the circumstances of limited U.S. receptivity to spent fuel return to the United States, can be an important element in U.S. efforts to develop solutions for foreign spent fuel disposition. The emergence of one or more multinational or international storage schemes, whether of regional or global applicability, could effectively overcome the contention that growing spent fuel accumulation demands a reprocessing solution. An additive benefit of such a development is to demonstrate the viability of multinational fuel cycle solutions which could evolve into a broader role in the nuclear fuel cycle, either on the front-end or the back-end, in combination with acceptable technical and institutional modifications to the fuel cycle designed to reduce the proliferation risk. The performance of such activities under multinational or international auspices could help overcome charges of discrimination which would inevitably accompany a regime under which performance of these activities was permitted in certain countries and denied to others. Spent fuel storage, due to the immediacy of its need and its relatively less demanding technology, may lend itself more readily to the creation of multinational or international institutions than any other fuel cycle activity.

United States policy calls for indefinite deferral of reprocessing in its conventional mode - that is, any process which,

as in the case of present day solvent extraction techniques, leads to the separation of weapons-useable plutonium. At the same time, the search for and evaluation of alternative processes which may allow recovery and utilization of the energy values of spent fuel at acceptable proliferation risks, is also an integral and important part of U.S. policy. This search and evaluation is institutionalized in the International Nuclear Fuel Cycle Evaluation - INFCE. This overall policy has provided the backdrop for the study.

The study has found that consideration of storage options cannot be entirely divorced from consideration of the arrangements by which storage would be terminated, either by permanent disposal or recovery of energy values. A recognition of this linkage is a necessary and important feature of this report.

The alternative strategy development process of the study draws on imputed nonproliferation values of international or multinational arrangements in dealing with spent fuel management.

The need for internationalization of the fuel cycle has generated much discussion, developing a range of views. These include advocating to:

- a) put the entire fuel cycle in place at one time (assuming reprocessing)
- b) put in place a system dedicated to the once-through cycle and leading to permanent storage of unprocessed spent fuel
- c) put in place a fuel cycle system which can adjust to the technical and institutional nonproliferation solutions as they are developed and accepted by nations.

These views or approaches must, of course, make sense to participating nations and industries in order to be implemented, and it is possible that more than one of these approaches will become a reality.

The approach of this study centers on the third choice - to put in place a fuel cycle system which can adjust to the technical and institutional nonproliferation solutions as they are developed and accepted by nations. The approach centers on the concept of centralized large scale spent fuel

storage under international or multinational auspices or control. The concept does not imply affirmative decision making for reprocessing, nor does it rule out later reprocessing if agreement has been reached on the technical and institutional conditions required to make reprocessing an accepted activity from the nonproliferation standpoint. The concept is structured to relieve spent fuel logistics pressures and provide a basis for accommodating longer term decisions on fuel cycle management. For the purposes of this study, the assumed nonproliferation values of the international or multinational arrangements in such a concept are summarized as follows:

- a) Relief of pressure for premature fuel movement into a reprocessing system: The study country findings identify a significant amount of spent fuel positioned or potentially positioned for movement into domestic or foreign reprocessing systems. The absence of a workable spent fuel storage alternative providing a reprocessing deferral scenario provides a continued pressure for solutions dependent upon near term and intermediate reprocessing decisions.

It should be clear in an international storage scheme that reprocessing (or other recovery function) would not take place unless the nonproliferation concerns were resolved for such an operation and that it was agreed that reprocessing was desirable from the view of economics and resource conservation in certain countries. In addition to relieving the pressure for reprocessing decisions, the international storage, if under multinational custody as well as IAEA safeguards, could, under appropriate siting and other conditions, provide greater storage security than national storage.

- b) Reduction of incentives for national fuel cycle activities, including national reprocessing: The centralized collection of spent fuel from a number of nations can be effected to favor international solutions in the disposition decisions following storage. International solutions in areas such as reprocessing provide an important intrinsic non-proliferation advantage over national reprocessing because of the possibilities of strengthened nonproliferation assurance obtainable from international arrangements.

Again in the case of reprocessing, the existence of a national facility in a particular region could be destabilizing to countries in the region which might believe they need a national facility to balance against proliferation uncertainties.

Obviously, a country with an identified national reprocessing facility has a significant advantage if it chooses to abrogate its safeguard and peaceful uses obligations.

Discussion of "Materials Accountability and Control Regime" considerations is found in Appendix B and is an important background for strategy development.

2.4 COUNTRY RELATED GSFLS CHARACTERISTICS

2.4.1 Categorization of GSFLS Characteristics

Catagories of country related characteristics which are likely to affect a country's attitude with regard to alternative GSFLS strategies are described below:

- I. Storage Situation: Information pertaining to the plans and programs for spent fuel storage, both through national or international means, also including information on plans for reprocessing and interim and permanent storage of waste, as it directly relates to the spent fuel storage situation. The time frame in which the spent fuel storage problem becomes nationally important is also stated.
- II. Special National Concerns Over Spent Fuel or Related Matters. Information pertaining to characteristics of the national situation which are anomalous or otherwise of particular relevance. These include special legal requirements, if any, to close the back-end of the nuclear fuel cycle, and the national interests, if any, placed on the residual energy value of spent fuel.
- III. Objectives for the Nuclear Fuel Cycle. Information pertaining to objectives for nuclear power, within the government and other sectors. Particularly important is the degree of commitment to and rationale for commercial reprocessing.
- IV. Industrial/Economic Strength. Information pertaining to the degree of sophistication, component manufacturing and construction capability of the nations' nuclear industry. Also, relevant information on special economic or industrial situations.

- V. Relevant International Ties. Information pertaining to international arrangements, agreements and relationships which particularly affect spent fuel decision making.
- VI. Receptivity to Nonproliferation Objectives and to Additional International Partnerships Relevant to Spent Fuel. Receptivity to nonproliferation objectives is analysed for each country to assess the degree to which it would accept alternative spent fuel disposition arrangements. The objectives used for this analysis involve: (1) a reprocessing cancellation scenario, (2) a reprocessing deferral scenario, and (3) variations of international arrangements.
- VII. Quality as a Host. Information pertaining to the ability of the country to host a multinational spent fuel, or related, arrangement. Includes information on ability to provide a suitable site, acceptance of the idea by the nation's political system, and acceptability as a host by other potential partners to the arrangements.

The above characteristics are summarized for the following countries in Figure 2-1 and 2-2:

- a) United States - (Ref. Figure 2-1).
- b) Pacific Basin countries, including Japan, the Republic of China (ROC), the Republic of Korea (ROK), Philippines - (Ref. Figure 2-1).
- c) European countries, including Austria, Belgium, Denmark, France, Federal Republic of Germany (FRG), Italy, Netherlands, Spain, Sweden, Switzerland, United Kingdom (U.K.) - (Ref. Figure 2-2).

CATEGORY	UNITED STATES	JAPAN	ROC	ROK	PHILIPPINES
I. Plans, Programs and Issues					
1. Interim Spent Fuel Fuel Storage	<ul style="list-style-type: none"> • General ARS expansion • Planning AFR 	<ul style="list-style-type: none"> • General ARS expansion • Planning AFR as front end to reprocessing 	<ul style="list-style-type: none"> • No AFR plans • ARS sufficient 	<ul style="list-style-type: none"> • No AFR plans • ARS sufficient 	<ul style="list-style-type: none"> • No AFR plans
2. Timing of Interim Storage Problem	<ul style="list-style-type: none"> • Near Term Problem 	<ul style="list-style-type: none"> • Near term 	<ul style="list-style-type: none"> • Not pressing 	<ul style="list-style-type: none"> • Not pressing 	<ul style="list-style-type: none"> • Not pressing
3. Interim HLW Storage	<ul style="list-style-type: none"> • No plans 	<ul style="list-style-type: none"> • No plans • Expects HLW from reprocessing to remain with BNFL/COGEMA 	<ul style="list-style-type: none"> • No plans 	<ul style="list-style-type: none"> • No plans 	<ul style="list-style-type: none"> • No plans
4. Permanent Fuel Storage	<ul style="list-style-type: none"> • Plans developing 	<ul style="list-style-type: none"> • No plans 	<ul style="list-style-type: none"> • No plans 	<ul style="list-style-type: none"> • No plans 	<ul style="list-style-type: none"> • No plans
5. Permanent Waste Storage	<ul style="list-style-type: none"> • Plans developing 	<ul style="list-style-type: none"> • Search for site underway - likelihood negative 	<ul style="list-style-type: none"> • No plans 	<ul style="list-style-type: none"> • No plans 	<ul style="list-style-type: none"> • No plans
6. Reprocessing	<ul style="list-style-type: none"> • Reprocessing deferral 	<ul style="list-style-type: none"> • Pilot plant operating • Existing contracts with BNFL/COGEMA • Planning commercial plant 	<ul style="list-style-type: none"> • No plans 	<ul style="list-style-type: none"> • No plans 	<ul style="list-style-type: none"> • No plans
7. Transportation	<ul style="list-style-type: none"> • Plans developing • Current domestic capability limited 	<ul style="list-style-type: none"> • NTS - domestic shipments • PNTL - foreign shipments 	<ul style="list-style-type: none"> • No plans 	<ul style="list-style-type: none"> • No plans 	<ul style="list-style-type: none"> • No plans
II. Special National Concerns					
1. Legal Obligation on Back-End	<ul style="list-style-type: none"> • No legal requirements • Domestic pressures to solve back-end 	<ul style="list-style-type: none"> • Back-end solution required for continuation of nuclear program 	<ul style="list-style-type: none"> • No legal requirement • Little domestic pressure to solve back-end 	<ul style="list-style-type: none"> • No legal requirement • Little domestic pressure to solve back-end 	<ul style="list-style-type: none"> • No legal requirement • Little domestic pressure to solve back-end
2. Value Placed on Spent Fuel	<ul style="list-style-type: none"> • At present zero 	<ul style="list-style-type: none"> • Positive 	<ul style="list-style-type: none"> • Positive 	<ul style="list-style-type: none"> • Positive 	<ul style="list-style-type: none"> • Uncertain

Figure 2-1: U.S. & Pacific Basin GSFLS Related Characteristics

	UNITED STATES	JAPAN	ROC	ROK	PHILIPPINES
III. Objective For Nuclear Fuel Cycle					
1. National Objectives	<ul style="list-style-type: none"> Continue development of nuclear power capability Close fuel cycle with permanent spent fuel storage 	<ul style="list-style-type: none"> Reprocessing planning Breeder deployment after year 2000 	<ul style="list-style-type: none"> Aggressive nuclear electrification 	<ul style="list-style-type: none"> Aggressive nuclear electrification 	<ul style="list-style-type: none"> Develop nuclear power program
2. Utility Sector Objectives	<ul style="list-style-type: none"> Same as national 	<ul style="list-style-type: none"> Same as national 	<ul style="list-style-type: none"> Same as national 	<ul style="list-style-type: none"> Same as national 	<ul style="list-style-type: none"> Same as national
3. Reprocessing Rationales	<ul style="list-style-type: none"> Reprocessing deferral 	<ul style="list-style-type: none"> LWR recycle Acquire Pu for breeder R&D & commercialization 	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> None
IV. Industrial/Economic Strength	<ul style="list-style-type: none"> Developed industrial infrastructure Indigenous hardware 	<ul style="list-style-type: none"> National R&D capability Effective coordination of public & private sectors 	<ul style="list-style-type: none"> No indigenous hardware 	<ul style="list-style-type: none"> No indigenous hardware 	<ul style="list-style-type: none"> No indigenous hardware
V. Relevant International Ties	<ul style="list-style-type: none"> IAEA NPT 	<ul style="list-style-type: none"> DOGEMA/DNPL contracts IAEA, NPT 	<ul style="list-style-type: none"> No longer IAEA 	<ul style="list-style-type: none"> IAEA, NPT 	<ul style="list-style-type: none"> IAEA, NPT
VI. Receptivity to International Partnerships					
1. Interest in Bi- or Multi-National Alternative	<ul style="list-style-type: none"> Interested in developing multinational alternatives 	<ul style="list-style-type: none"> Would consider if 1. equal treatment 2. does not compromise breeder development 	<ul style="list-style-type: none"> Open to participation in Pacific Basin Arrangement 	<ul style="list-style-type: none"> Open to participation in Pacific Basin arrangement 	<ul style="list-style-type: none"> Open to participation in Pacific Basin arrangement
2. Interest in U.S. Offer	<ul style="list-style-type: none"> ---- 	<ul style="list-style-type: none"> Uncertain 	<ul style="list-style-type: none"> Positive 	<ul style="list-style-type: none"> Positive 	<ul style="list-style-type: none"> Positive
VII. Quality As a Host					
1. Public Acceptance (multi-national)					
Interim Storage	<ul style="list-style-type: none"> Positive (limited quantities) 	<ul style="list-style-type: none"> Negative 	<ul style="list-style-type: none"> Negative 	<ul style="list-style-type: none"> Uncertain 	<ul style="list-style-type: none"> Positive
Reprocessing	<ul style="list-style-type: none"> Negative 	<ul style="list-style-type: none"> Negative 	<ul style="list-style-type: none"> Negative 	<ul style="list-style-type: none"> Uncertain 	<ul style="list-style-type: none"> Positive
Permanent Storage	<ul style="list-style-type: none"> Uncertain 	<ul style="list-style-type: none"> Negative 	<ul style="list-style-type: none"> Negative 	<ul style="list-style-type: none"> Uncertain 	<ul style="list-style-type: none"> Positive
2. Industrial Capability for Reprocessing	<ul style="list-style-type: none"> Existing 	<ul style="list-style-type: none"> Intermediate/Late Term 	<ul style="list-style-type: none"> No National Objectives 	<ul style="list-style-type: none"> No National objectives 	<ul style="list-style-type: none"> No National Objectives
3. Siting (Technical) Permanent Storage	<ul style="list-style-type: none"> Yes 	<ul style="list-style-type: none"> No 	<ul style="list-style-type: none"> Yes 	<ul style="list-style-type: none"> Yes 	<ul style="list-style-type: none"> Yes
4. Weapons State	<ul style="list-style-type: none"> Yes 	<ul style="list-style-type: none"> No 	<ul style="list-style-type: none"> No 	<ul style="list-style-type: none"> No 	<ul style="list-style-type: none"> No
5. NPT	<ul style="list-style-type: none"> Yes 	<ul style="list-style-type: none"> Yes 	<ul style="list-style-type: none"> Yes 	<ul style="list-style-type: none"> Yes 	<ul style="list-style-type: none"> Yes

Figure 2-1: U.S. & Pacific Basin GSFLS Related Characteristics, con't.

CATEGORY	UNITED KINGDOM	FRANCE	GERMANY	SPAIN	ITALY	SWITZERLAND	NETHERLANDS	SWEDEN	AUSTRIA	DENMARK	BELGIUM
i. Plans, Programs and Issues											
1. Interim Spent Fuel Fuel Storage	<ul style="list-style-type: none"> Domestic program is front-end to reprocessing Offers foreign services as front end of reprocessing 	<ul style="list-style-type: none"> Domestic program is front-end to reprocessing Offers foreign services as front end of reprocessing 	<ul style="list-style-type: none"> ARS expansion AFR plans 	<ul style="list-style-type: none"> General ARS expansion AFR plans 	<ul style="list-style-type: none"> Has ARS and AFR expansion plans MAGNOX to BNFL 	<ul style="list-style-type: none"> Plans to expand ARS capacity Plans uncertain 	<ul style="list-style-type: none"> No plans beyond existing ARS 	<ul style="list-style-type: none"> Has plans for ARS Expansion and AFR 	<ul style="list-style-type: none"> Politically unacceptable; but has ARS expansion and AFR plans 	<ul style="list-style-type: none"> No plans now 	<ul style="list-style-type: none"> General ARS expansion AFR plans
2. Timing of Interim Storage Problem	<ul style="list-style-type: none"> Oxide, fuel not pressing MAGNOX fuel to be reprocessed 	<ul style="list-style-type: none"> Not pressing 	<ul style="list-style-type: none"> Urgent 	<ul style="list-style-type: none"> Urgent short term problem Long term problem if no reprocessing 	<ul style="list-style-type: none"> Long-term problem if no reprocessing 	<ul style="list-style-type: none"> Urgent due to legal problem 	<ul style="list-style-type: none"> Urgent Loss of FCR and public acceptance issue 	<ul style="list-style-type: none"> Urgent due to legal problem 	<ul style="list-style-type: none"> Urgent due to legal problem 	<ul style="list-style-type: none"> Intermediate term problem; if nuclear program is approved 	<ul style="list-style-type: none"> Not pressing
3. Interim HLW Storage	<ul style="list-style-type: none"> Domestic program is linked to reprocessing May offer foreign services at Windscale 	<ul style="list-style-type: none"> Domestic program is linked to reprocessing Offers foreign services at La Hague 	<ul style="list-style-type: none"> Domestic program is linked to reprocessing No foreign 	<ul style="list-style-type: none"> No plans 	<ul style="list-style-type: none"> No plans 	<ul style="list-style-type: none"> No plans 	<ul style="list-style-type: none"> No plans 	<ul style="list-style-type: none"> No plans yet Public acceptance is a problem 	<ul style="list-style-type: none"> Politically unacceptable No plans 	<ul style="list-style-type: none"> No plans 	<ul style="list-style-type: none"> Domestic program linked to reprocessing No foreign fuel
4. Permanent Fuel Storage	<ul style="list-style-type: none"> Negative 	<ul style="list-style-type: none"> Negative 	<ul style="list-style-type: none"> Negative 	<ul style="list-style-type: none"> No plans 	<ul style="list-style-type: none"> No plans 	<ul style="list-style-type: none"> No plans 	<ul style="list-style-type: none"> No plans 	<ul style="list-style-type: none"> No viable plan Public acceptance problem 	<ul style="list-style-type: none"> No viable plan Public acceptance problem 	<ul style="list-style-type: none"> No plans now 	<ul style="list-style-type: none"> Negative
5. Permanent Waste Storage	<ul style="list-style-type: none"> No plans now 	<ul style="list-style-type: none"> No plans now 	<ul style="list-style-type: none"> Plans for permanent storage of HLW at Gorleben 	<ul style="list-style-type: none"> No plans now 	<ul style="list-style-type: none"> Currently evaluating "blue clay" 	<ul style="list-style-type: none"> Currently under study 	<ul style="list-style-type: none"> Would like COGEMA to keep waste after reprocessing 	<ul style="list-style-type: none"> Under consideration Public acceptance is a problem 	<ul style="list-style-type: none"> No plans 	<ul style="list-style-type: none"> No plans now 	<ul style="list-style-type: none"> No plans now
6. Reprocessing	<ul style="list-style-type: none"> Foreign services at Windscale (BNFL) 	<ul style="list-style-type: none"> Committed to reprocessing domestically Foreign services offered at La Hague (COGEMA) 	<ul style="list-style-type: none"> Committed to reprocessing domestically at Gorleben 	<ul style="list-style-type: none"> Plan to build national reprocessing eventually Intermediate term capability unclear 	<ul style="list-style-type: none"> Plan to build national reprocessing eventually Intermediate term capability unclear 	<ul style="list-style-type: none"> LWR reprocessing and recycle services outside - negotiating extension 	<ul style="list-style-type: none"> No domestic plans Extending URG contracts pending INFCE results 	<ul style="list-style-type: none"> No domestic plans Plan to purchase services from COGEMA 	<ul style="list-style-type: none"> Plan to purchase services from COGEMA COGEMA/BNFL requirement to return HLW back to Austria 	<ul style="list-style-type: none"> No active policy yet 	<ul style="list-style-type: none"> Committed to domestic reprocessing
7. Transportation	<ul style="list-style-type: none"> BNFL uses NTL and PNTL for foreign shipments to Windscale 	<ul style="list-style-type: none"> Member of TN and future arrangements with PNTL to ship Japanese fuel to La Hague 	<ul style="list-style-type: none"> Some national transport planning FRG is a member of "N" 	<ul style="list-style-type: none"> Ship to Windscale using NTL 	<ul style="list-style-type: none"> Cask design underway Used NTL to ship fuel to Windscale 	<ul style="list-style-type: none"> NTL or TN to provide transport services 	<ul style="list-style-type: none"> NTL or TN to provide transport services 	<ul style="list-style-type: none"> NTL or TN to provide transport services 	<ul style="list-style-type: none"> NTL or TN to provide transport services 	<ul style="list-style-type: none"> No plans now 	<ul style="list-style-type: none"> Initial planning at this point
ii. Special National Concerns											
1. Legal Obligation on Back-End	<ul style="list-style-type: none"> Some public/political pressure to solve back-end 	<ul style="list-style-type: none"> Some public/political pressure to solve back-end 	<ul style="list-style-type: none"> Back-end solution required for continuation of nuclear program 	<ul style="list-style-type: none"> No legal requirement Little domestic pressure to solve back-end 	<ul style="list-style-type: none"> No legal requirement Little domestic pressure to solve back-end 	<ul style="list-style-type: none"> Local opposition to permanent storage Permanent storage (HLW) may be required 	<ul style="list-style-type: none"> Local opposition to permanent storage 	<ul style="list-style-type: none"> Back-end solution required for continuation of nuclear program 	<ul style="list-style-type: none"> Back-end solution required for continuation of nuclear program 	<ul style="list-style-type: none"> Back-end solution required for continuation of nuclear program 	<ul style="list-style-type: none"> No legal requirement
2. Value Placed on Spent Fuel	<ul style="list-style-type: none"> Positive 	<ul style="list-style-type: none"> Positive 	<ul style="list-style-type: none"> Positive 	<ul style="list-style-type: none"> Positive 	<ul style="list-style-type: none"> Positive 	<ul style="list-style-type: none"> Government uncertain, under study Utilities - positive 	<ul style="list-style-type: none"> Negative to zero 	<ul style="list-style-type: none"> Government uncertain, under study Utilities - positive 	<ul style="list-style-type: none"> Government uncertain, under study Utilities - positive 	<ul style="list-style-type: none"> Government uncertain, under study Utilities - positive 	<ul style="list-style-type: none"> Positive

Figure 2-2: European GSFLS Related Characteristics

CATEGORY	UNITED KINGDOM	FRANCE	GERMANY	SPAIN	ITALY	SWITZERLAND	NETHERLANDS	SWEDEN	AUSTRIA	DENMARK	BELGIUM
III. Objective For Nuclear Fuel Cycle											
1. National Objectives	• Close fuel cycle based on reprocessing and breeder	• Close fuel cycle based on reprocessing and breeder	• Close fuel cycle based on reprocessing and breeder	• Develop an independently capable national fuel cycle • Aggressive nuclear electrification • National LWR recycle • Reprocess eventually	• Develop and independently capable national fuel cycle • National breeder • National LWR recycle	• Require permanent storage of either fuel or HLW	• LWR's to provide large part of electricity requirement • Breeder program with FRG in doubt	• Require permanent storage of either fuel or HLW	• Purchase reprocessing services	• Uncertain	• LWR recycle • Supplier nation
2. Utility Sector Objectives	• Essentially same as national	• Same as national	• Same as national	• Same as national	• Same as national	• Same as national	• Same as national	• Utilities looking for solution to back-end	• Same as national	• Same as national	• Same as National
3. Reprocessing Rationales	• Acquire Pu for breeder fueling • Pu stockpiled until breeder introduction 1990 • Waste Management	• Acquire Pu for breeder RD&D and commercialization • Waste Management	• LWR recycle • Acquire Pu for breeder RD&D and commercialization • Waste Management	• LWR recycle	• LWR recycle • Breeder RD&D • Waste management	• LWR recycle • Waste management	• Waste management • May be LWR recycle • Maybe breeder • Suspended plans until after NFCE	• LWR recycle • Waste management	• LWR recycle under consideration • Waste Management	• LWR recycle • Waste management	• LWR recycle • Breeder deployment
IV. Industrial/Economic Strength	• Strong basic research and nuclear manufacture	• Effective coordination for CEA, EDF and industry • Ample government fundings • Ties with EC, especially F.R.G. and U.K.	• Effective coordination of private and public sectors • Intra-European R&D arrangements	• Developing fast • Can manufacture up to 80% LWR indigenously	• Developed industrial infrastructure • Ties with EC • No indigenous hardware yet	• Financial capability to remain buyer in nuclear market	• Industrial and R&D capability	• Design and builds own reactors • Industrially independent	• No indigenous industrial economic infrastructure for nuclear fuel cycle program	• No indigenous industrial infrastructure to design or build reactor	• Developed industrial infrastructure • Intra-European R&D arrangements
V. Relevant International Ties	• EC, URG, URENCO, NPT, PNTL, UERATM, IAEA, NPT	• EC, URG, SERENA, EURODIF, COREDIF • EURATOM, IAEA • 5x colonies in Africa • Uranium supplies	• EC, URG, SERENA, URENCO • EURATOM, IAEA, NPT	• EURODIF, COREDIF, IAEA • Non-NPT, Non-NATO	• EC, SERENA • EURODIF, COREDIF, EURATOM, NPT, IAEA	• EC, IAEA, NPT • Especially active in London Club, IEA	• BC, BENELUX, EURATOM, IAEA, NPT	• IAEA, NPT • Nordic Council	• Balance between East-West • IAEA, NPT	• EC, ties with BENELUX, EURATOM, IAEA, IAEA, Nordic Council	• EC, SERENA, EURODIF • EURATOM, IAEA, NPT
VI. Receptivity to International Partnerships											
1. Interest in Bi- or Multi-National Alternative	• Would consider after Windscale hearings	• Interested in nations that stabilize U ore market & 2) open new nuclear markets for France	• Would consider after Gorleben momentum established	• Could be interested if reduced hard currency payments	• Could be interested if reduced hard currency payments	• Yes, if it will provide permanent solution to back-end	• Yes, if it will provide permanent solution to back-end	• Yes, if it will provide permanent solution to back-end	• Yes, if it will provide permanent solution to back-end	• Yes, if it will provide permanent solution to back-end	• Would consider if future AFR storage problems develop
2. Interest in U.S. Offer	• Negative	• Negative	• Negative	• Uncertain	• Uncertain	• Positive	• Positive	• Positive	• Positive	• Positive	• Negative
VII. Quality As a Host											
1. Public Acceptance (multi-national)											
Interim Storage	• Yes	• Yes	• No	• Uncertain	• Yes	• No	• No	• No	• No	• Uncertain	• Uncertain
Reprocessing	• Yes	• Yes	• No	• Uncertain	• Yes	• No	• No	• No	• No	• Uncertain	• Uncertain
Permanent Storage	• Uncertain	• No	• No	• Uncertain	• No	• No	• No	• No	• No	• Uncertain	• No
2. Industrial Capability for Reprocessing	• Existing	• Existing	• Near Term	• Late intermediate term	• Late intermediate term	• No national objective but intermediate term possible	• Not national objective but intermediate term possible	• Not national objective but intermediate term possible	• Not national objective but try to tie in with FRG	• Not national objective but intermediate term possible	• Existing
3. Siting (Technical/Permanent Storage)	• Maybe	• Maybe	• Yes	• Maybe	• Maybe	• Maybe	• No	• Yes	• Maybe	• No	• No
4. Weapons State	• Yes	• Yes	• No	• No	• No	• No	• No	• No	• No	• No	• No
5. NPT	• Yes	• No	• Yes	• No	• Yes	• Yes	• Yes	• Yes	• Yes	• Yes	• Yes

Figure 2-2: European GSFLS Related Characteristics, con't.

2.4.2 Summary Evaluation of GSFLS Characteristics

This subsection provides a summary evaluation of the country related GSFLS characteristics (Ref. Section 2.2.1) as they might relate to broader regional and/or multinational spent fuel logistics arrangements.

2.4.2.1 United States

U.S. spent fuel disposition policies call for indefinite deferral of commercial plutonium reprocessing and recycling associated with its domestic nuclear power program; and support for international nuclear power programs in terms of (a) the possibility of bringing back limited amounts of foreign spent fuel and (b) assistance in the development of international and multinational arrangements covering the back-end of the fuel cycle.

The foregoing policy guidelines, coupled with a relatively large and mature nuclear power program, offers the U.S. a particularly flexible framework for designing initiatives and accepting potential roles and partnerships associated with the shaping of GSFLS arrangements.

The following list of generic possibilities for developing cooperative undertakings and their implications are briefly outlined for illustration purposes:

- o Potential Host Site: As noted above, current U.S. policy has indicated the possibility that a limited amount of spent fuel could be stored within the U.S. in support of nonproliferation goals.
- o Possible Spent Fuel Contribution: With its large nuclear program, the U.S. could ensure adequate load balancing for newly implemented spent fuel logistics concepts in adjoining regions (e.g. Pacific Basin).

- o Concept Development: U.S. experience and resources in international business management could be appropriately tapped for designing tailor-fitted multinational concepts as the prospective parties of multinational arrangements would see fit.
- o RD&D Cooperation: U.S. experience in geological storage and surface AFR alternatives could be shared with developing countries as an incentive to multinational cooperation.
- o Financial Support: The U.S. private bond market presents attractive characteristics (i.e., long term debt maturity, and fixed interests) for the financing of multinational concepts that could be sited in countries not in possession of such financial capabilities.
- o Technical and Managerial Assistance: The U.S. could provide industrial leadership in facilities development and operation. Such an assistance could be particularly useful in the startup phases of multinational projects.
- o Contingency backup fuel cycle services: The U.S. could provide contingency backup services in the event of performance uncertainty of newly launched multinational centers.
- o Assistance in setting and implementing nonproliferation criteria: U.S. experience in the field of non-proliferation could be made available to multinational partners.

2.4.2.2 Pacific Basin Countries

The Pacific Basin countries can be segregated largely according to the size, maturity and sophistication of a member

country's nuclear power program which in turn affects the immediacy of its spent fuel disposition needs and its long term nuclear power program objectives. Accordingly, Figure 2-3 catagorizes the Pacific Basin countries.

Figure 2-3
Grouping of Pacific Basin Countries

<u>Group</u>	<u>Similar Characteristics</u>	<u>Countries</u>
A	<ul style="list-style-type: none"> • Mature nuclear power programs • Near term need for AFR spent fuel disposition • Important long term energy recovery needs 	Japan
B	<ul style="list-style-type: none"> • Developing nuclear power programs • Intermediate term need for AFR spent fuel disposition • Moderate long term energy recovery needs. 	Republic of China (ROC) Republic of Korea (ROK) Philippines
C	<ul style="list-style-type: none"> • Early planning of domestic nuclear power programs • Possible long term AFR spent fuel disposition need • Potentially important in export of fuel cycle resources 	Other Pacific Basin countries (e.g. Indonesia, Australia)

The predominance of Japanese spent fuel to the end of the century, in concert with current Japanese interest in national reprocessing, makes Japan the critical Western Pacific nation influencing a Pacific Basin spent fuel arrangement. With the highest energy import dependence of any major industrial nation, Japan sees the breeder as an essential element in the development of a strategy to reduce this dependence. It will be necessary to accommodate Japan's long term energy resource needs within a regional concept in order for Japan to contemplate substituting a regional spent fuel disposition program for a national program.

The Group B countries are viewed as participants within a Pacific Basin spent fuel disposition program either as users of the regional system or cooperating members of a regional consortium. These countries would likely accept the nonproliferation conditions inherent in the system in order to benefit from the logistical and economic advantages offered by the regional system.

The Group C countries would only become involved in a Pacific Basin regional or multinational spent fuel disposition concept when and if one or more of the following conditions were to be in effect:

- a) Away from reactor spent fuel disposition requirements necessitates participation as a "user" or cooperating member within a Pacific Basin consortium.
- b) Coupling of fuel cycle resource supplier role to spent fuel disposition arrangements becomes important.

2.4.2.3 European Countries

The institutional aspects of European spent fuel arrangements are significantly different from the Pacific Basin. As shown in Figure 2-2 (Ref.) Europe reflects many differing national interests which rule out simple approaches to a regional or multinational spent fuel logistics system. Commercial reprocessing is extant and expanding with as many as six nations having various degrees of commitment to the national reprocessing path and having differing reprocessing rationales.

The three major nuclear power countries within Europe - U.K., France and F.R.G - along with Belgium are planning on reprocessing for varying reasons. Each of these countries is focused on the resource conservation issue and is in some stage of breeder program development. Each supports the view that reprocessing is the appropriate technical preconditioning for permanent storage. Of these, only Germany is currently implementing a permanent geologic storage program. The other three have not yet crystallized their permanent storage plans for high level waste. The U.K. and France are marketing reprocessing services to foreign countries while the Germans must pursue their nationally-oriented program to assure continued domestic reactor plant development. Belgium has now decided to use its small Mol reprocessing plant and buy reprocessing services from COGEMA to complement its domestic capability and satisfy its domestic need. The French are leading to a plutonium economy. None of these reprocessing countries is amenable to becoming the permanent storage site for Europe's spent fuel.

Several European countries have not opted for national reprocessing programs but do have legal or political requirements to have an acceptable solution for the permanent disposal of nuclear wastes before continuing with their nuclear programs.

These include Switzerland, the Netherlands, Sweden, Austria, Denmark, and Finland. As a result of this requirement, and the lack of domestic solutions for processing spent fuel, these nations have either signed agreements with, are in the process of negotiating with or are considering procuring spent fuel reprocessing and high level waste (HLW) conditioning services from BNFL and/or COGEMA. The subject European countries would likely cooperate in the development of a regional and/or multinational nonproliferation arrangement provided it centrally addresses the permanent disposition problem.

Italy and Spain have a different situation from other countries in Europe, but have a similar resulting policy. Neither of these nations have legal or pressing internal political pressure to arrive at a permanent storage solution. However, both Italy and Spain are traveling along paths which could lead toward domestic reprocessing in the late 1990's. An alternative would be to assure a reliable and economic source for either reprocessed or fresh fuel, together with an eventual solution to the permanent disposal problem. This could be accomplished through regional and/or multinational spent fuel disposition arrangements.

Figure 2-3 categorizes the European countries in terms of three groups differentiated by their dominant national concerns.

Figure 2-3

DOMINANT NATIONAL CONCERNS AND RESULTING COUNTRY GROUPS,
MINIMUM OFFER, AND SPENT FUEL FLOW CONDITION

<u>CATEGORIES</u> <u>OF DOMINANT</u> <u>NAT'L CONCERNS</u>	<u>NATIONS/</u> <u>DOMINANT</u> <u>CONCERNS</u> <u>GROUPINGS</u>	<u>ATTITUDES</u> <u>TOWARD NAT'L</u> <u>REPROCESSING</u> <u>DEFERRAL</u>	<u>MINIMUM OFFER</u> <u>CONDITION</u> <u>FOR CONCEPT</u> <u>FORMATION</u>	<u>SPENT FUEL</u> <u>FLOW</u> <u>CONDITION</u>
WASTE MANAGEMENT - ORIENTED GROUP (Group #1)	Sweden Norway Finland Denmark Netherlands ¹ Switzerland Austria Luxemburg ²	More Cooperative Attitude	AFR Storage (Bridge) to Develop Permanent Storage Scheme ^{3/}	Permanent Spent Fuel Disposal Outside of Group #1 Countries
NAT'L REPROCESSING - ORIENTED GROUP (Group #2)	Italy ¹ Spain Belgium ¹ U.K.	Less Cooperative Attitude	Nonprolifera- tion Criteria For Conditional Reprocessing	Adequate Load Balancing for Reprocess- ing Activities
COMMERCIAL FBR - ORIENTED GROUP (Group #3)	FRG ^{1,2} France ¹			

1/ SERENA Agreement Signators

2/ Luxemburg will follow FRG's waste management options

3/ Does not preclude multinational reprocessing

2.5 GLOBAL SPENT FUEL PROFILES

2.5.1 Nuclear Power Profiles

Figures 2-4 through 2-6 characterize forecasted nuclear power profiles that form the basis for this study. The rationale for these forecasts is described below.

Nuclear power growth forecasts are conventionally based on projections of total energy and electricity growth. Any uncertainty in either the energy or electricity projections will tend to be propagated and to some extent, amplified in the nuclear growth forecasts. The evaluation of data for nuclear plants either already in operation, under construction or "firmly" planned, minimizes uncertainty through about the mid-eighties. Since nuclear growth forecasts for the longer term are generally obtained from econometric and energy network flow analyses, and judgments as to nuclear power contributions to electricity generation, they are subject to some considerable uncertainty.

In the year or so following the October 1973 Arab-Israeli war and associated oil embargo, many countries determined to increase their reliance on the nuclear option, and thus nuclear power forecasts became overly optimistic. However, even though relatively low fuel costs favor the nuclear option, high and escalating capital costs, fuel supply uncertainties, proliferation concerns, unresolved waste disposal issues, public acceptance problems, and the general lack of clear-cut energy policies in the industrially developed countries, have resulted in a state of pessimistic nuclear growth forecasts, each more so than its predecessor.

While it is possible to conceive of nuclear commitments for the near term being accelerated within the limitations of available lead time, it is easier to visualize the further slippage and cancellation of existing commitments. In short, through the mid-eighties, negative uncertainty is perceived as being larger than positive uncertainty. In the longer term,

FIGURE 2-4
SUMMARY OF NUCLEAR POWER GROWTH FORECASTS
FOR FOREIGN COUNTRIES STUDIED
(Gigawatt Electric)

COUNTRY	YEAR			
	1977	1985	1990	2000
Japan	8.0	27	50	90
Korea	-	2.4	4	10
Taiwan	-	3.1	7	12
Philippines	-	0.6	0.6	2
Pacific Basin:	8.0	33.1	61.6	114
United Kingdom*	8.1	10	15	35
France*	4.9	35	55	90
F.R.G.*	6.4	20	35	70
Sweden	3.9	9.4	11	16
Finland	0.4	2.1	4	8
Denmark*	-	-	1	3
Belgium*	1.7	5.4	7	10
Netherlands*	0.5	0.5	1.4	
Switzerland	1.1	5.9	8	12
Luxembourg*	-	1.2	2.4	2.4
Spain	1.1	12	16	25
Italy*	0.6	4.3	10	17
Austria	-	0.7	2	5
Yugoslavia	-	0.6	1.2	3
Europe:	28.7	107.1	169	299
Argentina	0.3	0.9	2	8
Brazil	-	1.9	7	20
Mexico	-	1.3	4	12
Canada	4.0	12	24	60
Iran	-	4.2	12	30
India	0.6	1.8	5	15
Other:	4.9	22.1	54	145
Total:	41.6	162.3	285	558

*European Economic Community countries; Republic of Ireland not listed above.

FIGURE 2-5

SUMMARY OF NUCLEAR POWER GROWTH FORECASTS
FOR NON-CPE* WORLD

(Gigawatt Electric)

<u>REGION/COUNTRY</u>	<u>1977</u>	<u>1985</u>	<u>1990</u>	<u>2000</u>
<u>Europe:</u>				
Norway	-	-	1	2
Portugal	-	-	1	2
Ireland	-	-	0.6	1.5
Greece	-	-	1	3
Turkey	-	-	1	3
Table 1 Countries	28.7	107	169	299
Subtotal	28.7	107	174	310
<u>Pacific Basin:</u>				
Australia	-	-	-	2
New Zealand	-	-	-	1
Table 1 Countries	8.0	33	62	114
Subtotal	8.0	33	62	117
<u>Asia/Africa:</u>				
Iran	0	4.2	12	30
India	0.6	1.8	5	15
Pakistan	0.1	0.1	2	6
South Africa	-	0.9	2	6
Egypt	-	-	1	4
Israel	-	-	1	4
Others	-	-	2	20
Subtotal	0.7	7.0	25	85
<u>Americas:</u>				
U.S.A.	47	113 (a)	195 (b)	380 (b)
Canada	4	12	24	60
Argentina	.3	.9	2	8
Brazil	-	1.9	7	20
Mexico	-	1.3	4	12
Others	-	-	1	8
Subtotal	51.3	129	233	488
Foreign Total	42	163	299	620
World Total	89	276	494	1000

*Non-CPE means non Centrally Planned Economy countries.

(a) FEA, September 1977

(b) ERDA, GJO, October 1977

FIGURE 2-6

SUMMARY OF NUCLEAR POWER FORECASTS
FOR MAJOR* CONTRIBUTING NON-CPE WORLD COUNTRIES

(Gigawatt Electric)

Country	YEAR			
	1977	1985	1990	2000
U.S.A	47	113	195	380
France	4.9	35	55	90
Japan	8.0	27	50	90
F.R. Germany	6.4	20	35	70
Canada	4.0	12	24	60
United Kingdom	8.1	10	15	35
Italy	0.6	4.3	10	17
Iran	-	4.2	12	30
Sweden	3.9	9.4	11	16
Total:	83	235	407	788
Percent of World Totals:	93	85	82	78

Note: Data rounded.

*Based on a forecast of greater than 10 GWe in 1990.

into the nineties and beyond, the lead times are long enough to accelerate nuclear power installations if energy policies so dictate.

In this section, recently published forecast data and related information were analyzed to derive a reasonably "valid" set of nuclear power growth projections through the end of the century for the countries of primary interest. The results are given in Figure 2-4. In order to present as complete a perspective as possible, up to date growth projections for other non-centrally planned economy (CPE) countries outside the scope of the study were reviewed. The results are given in Figure 2.5.

A comparison of the Figures 2-4 and 2-5 data show that the foreign growth totals in Figure 2-4 represent essentially all forecasted foreign nuclear growth through the mid-eighties and more than 90 per-cent through the end of the century. This of itself confirms the appropriateness of the list of countries selected for the GSFLS study.

The Figures 2-4 and 2-5 data show that the European Community currently represents about three-quarters of Western Europe's operating nuclear power and it is projected that the Community will maintain this position through the end of the century and possibly beyond. Western Europe as a whole is forecasted to have an installed nuclear capacity level approaching that of the U.S. Almost half of the nuclear power growth forecast for the next 20 to 30 years, will be sited in either North or South America; about four-fifths of this capacity is expected to be U.S. The Pacific Basin countries, including the U.S., Canada and Mexico, are forecasted to represent about 57 per-cent of future world growth, these countries currently represent about 77 per-cent of world operating capacity. As shown in Figure 2-6, as few as nine countries are forecasted to represent four-fifths of the world's nuclear power capacity through the end of the century; all of these countries, and no others, are forecasted, to have at least 10 GWe in operation by 1990.

It is estimated that the Figure 2-4 aggregate foreign forecasts have an uncertainty of plus 5 per-cent and minus 15 per-cent in 1985. The year 2000 forecasts are estimated to have a plus/minus uncertainty of about 40 per-cent. The long term negative uncertainty is derived from the possibility of either continuing moratorium situation or program cut-backs in many countries whereas the positive uncertainty is derived from what can be reasonably expected and obtained within available time frames. It is acknowledged that the positive uncertainty could be considered to be larger in the event of a dramatically increased acceptance of the nuclear option and the emergence of alternative energy supply difficulties.

The forecasts assume that the light water reactor (LWR) will predominate over the period of interest, and represent about 85 per-cent of the future foreign market through the end of the century. It is estimated that the LWR will tend to be distributed about 65 per-cent PWR and 35 per-cent BWR. The foreign growth forecast in 1985 is distributed approximately as follows: LWR - 80 per-cent; CANDU - 10 per-cent; GCR - 5 per-cent; AGR - 4 per-cent; and FBR, etc. - 1 per-cent. For the years 1990 and 2000, the distribution is approximately: LWR - 85 and 85 per-cent; CANDU - 10 and 11 per-cent; GCR - 2 and 1 per-cent; AGR - 2 and 1 per-cent; and FBR - 1 and 2 per-cent, respectively. The GCR (5.2 GWe) and the AGR (6.2 GWe) types are those already operating or under construction in the U.K. and the GCR (2.3GWe) types; no further commitment of these types are foreseen. The CANDU is forecasted to be the only type installed in Canada. It is anticipated that the CANDU/HWR type may represent an additional total of 5 to 10 GWe distributed in countries such as Italy, Korea, Argentina, Pakistan, India and other nations in Africa, Asia, and South America by the nineties.

For 1985, the European Economic Community is currently forecasting an installed nuclear capacity of 84.5 to 94.5 GWe, or a mean of about 90 GWe; Figure 2-4 and 2-5 project 76 GWe as

more likely. This lower number is based on the latest 1977 updated F.R.G. energy program passed by the Bonn Cabinet, the recent Italian revised National Energy Program, the latest French considerations, and the "holding" status of the U.K. nuclear program.

Most countries in Western Europe have been facing siting opposition from environmental and political groups. This is especially true in Germany, Sweden, Italy and the Netherlands. Spain has recently determined to reduce its further commitment to nuclear power by half by 1987 (only 13 or 14 plants will be operating and not 20 as anticipated earlier) and thus by the late eighties, only about 10 per-cent of Spanish energy demand will be served by nuclear power. In the Orient, Japan has reduced its nuclear power commitments for 1985 to between 26 and 35 GWe, as compared to 60 GWe only a year or two ago. In order for the 26 GWe level to be exceeded, the public acceptance and political climate must improve in the very near future.

It is noted that early in 1977, the IAEA forecasted a total of 26 to 40 GWe of installed nuclear power generating capacity in the developing countries by 1985, and that by the year 2000, 36 developing countries, six of which are Eastern European, will have a total of 293 to 437 GWe. These are believed to be somewhat optimistic projections.

On the positive side, there are indications of increasing awareness of the value of the nuclear option. This has recently been evidenced by some general political events in both the Netherlands and West Germany. Many European nations are developing energy programs which appear to recognize the long term advantages of substituting nuclear power for imported oil. Again, as in the cases of Germany and France, the export of nuclear technology is being used to trade for energy resources. An example of this is the Iranian export of oil balanced against nuclear plants from West Germany, France and the U.S. Iran currently plans an installed nuclear capacity of 23 GWe by 1994, and to that end has entered into procurement commitments for 9 GWe to be in operation by 1987.

2.5.2 Spent Fuel Generation Profiles

Figure 2-7 shows the distribution of spent fuel profiles projected to be generated by global reactors. The basis for the above figure is as follows:

- a) Wherever possible, actual reactor discharge data is used for known reactor programs - i.e., those in operation, under construction or planned reactors.
- b) Future reactor growth profiles are based on data given in Figures 2-4 through 2-6. For non-defined (future) reactors, it is assumed that spent fuel is discharged at 26 MTHM per 1000 MWe per year starting one year after reactor start-up.
- c) Centrally Planned Economies (CPE) reactors are not included.
- d) Only Light Water Reactors (LWR) are considered.
- e) It is assumed, for the purposes of the GSFLS study, that the GSFLS reactor population remains constant between the years 2000 and 2030.

2.5.3 Away-From-Reactor (AFR) Spent Fuel Disposition Profile

Figure 2-8 shows the global AFR spent fuel disposition profile which is used as a basis for this study. Figure 2-8 illustrates an important characteristic within the GSFLS framework, namely, that there are three distinctly different generic phases (time periods) which must be reconciled within a GSFLS strategy namely:

Near Term Phase (Pre-1983 $\pm$ 2 years)

The near term phase has relatively small cumulative spent fuel for AFR disposition. Solutions for near term fuel disposition need not pre-empt more optimal

longer term solutions. At this time the near spent fuel disposition paths for the various sectors shown in Figure 2-8 are as follows:

<u>Section</u>	<u>Near Term AFR Disposition Approach</u>
France/FRG/UK	- Centralized storage prior to reprocessing campaign startup in 1980-85 period.
Europe - Others	- Majority negotiating or signing agreements with COGEMA/BNFL for centralized storage prior to reprocessing services. Minority seeking to delay reprocessing decision and seeking AFR storage solution
Japan	- Signed agreement with BNFL/COGEMA for downstream reprocessing services. Agreement subject to U.S. MB-10 approvals.
Pacific Basin- Others	- No requirements
Mid.East/Latin America/Africa/ Others	- Localized requirement (e.g., India) seeking specialized solution.
U.S.	- Large centralized AFR storage program in planning stage.

Figure 2-7: Spent Fuel Discharge Profile

Figure 2-8: Away-From-Reactor Spent Fuel Disposition Profile
- cum 1000 MTHM -

Intermediate Term Phase (1983 to 2000)

The intermediate term is viewed as the most critical GSFLS time period in that appropriate decisions and actions must be taken in order (a) to accommodate the relatively large spent fuel disposition requirements occurring in that phase and (b) to provide the appropriate spent fuel disposition systems that can support longer term energy resource recovery programs.

The GSFLS concepts for the Pacific Basin and Europe (Ref. Parts II and III) are oriented towards solutions that can be implemented within the intermediate term and can meet the rationale described in Section 2.3.

The perceived posture and potential GSFLS participation for the various sectors during the intermediate term is as follows:

<u>Sector</u>	<u>Intermediate Term AFR Disposition Approach</u>
France/FRG/U.K./ Belgium	<ul style="list-style-type: none">- Currently on reprocessing path- Potential for accepting multinational nonproliferation controls (See Part III)
Europe - Others	<ul style="list-style-type: none">- Currently on either national reprocessing path or procurement of external reprocessing services.- Potential for implementing new European regional fuel cycle center (See Part III).
Japan	<ul style="list-style-type: none">- Currently on national reprocessing path (start-up in 1990's).- Potential for implementing new Pacific Basin regional fuel cycle center (See Part II).

Pacific Basin-
Others

- No firm plans at this time
- Potential for participation in Pacific Basin regional fuel cycle center (See Part II).

Mid.East/Latin
America/Africa/
Others

- No firm plans for majority. Some national reprocessing plans (e.g., Brazil).
- Potential for forming regional systems (e.g., Latin America) or joining other regional systems (e.g., Mexico participation in Pacific Basin system).

NOTE: Concepts for these areas were not developed during the GSFLS study.

U.S.

- Currently pursuing national "deferred reprocessing" path
- Potential for active participation in Pacific Basin regional fuel cycle center (See Part II) and "flexible" participation in support of European regional/multinational concepts (See Part III).

Long Term Phase (2000 to 2030)

All major spent fuel disposition decisions and implementation programs must be completed during the intermediate term phase in order to have a viable long term nuclear power program.

3.0 GSFLS TECHNICAL/FINANCIAL FRAMEWORK

3.1 INTRODUCTION

3.1.1 Purpose

The basic purposes of the technical and financial portions of the GSFLS study are:

- a) To develop an understanding of the technical/financial implications associated with global spent fuel disposition.
- b) To determine whether a technically and financially acceptable solution to the problem is possible.

3.1.2 Approach

The technical and financial effort was divided into two phases. The activities of these phases are discussed below:

a) Initial Phase

1) Technical

- a. The basic technology available for spent fuel transportation, storage, and disposal was reviewed to determine what physical elements could be used to develop a GSFLS.
- b. A functional analysis was conducted. In this analysis all of the steps associated with the handling, processing, and storage of the fuel was determined. Each step was examined to verify whether it could be done in terms of the available technology.

- c. Using the basic available technology and the functional analysis, building block designs were developed. These designs covered elements such as water basins, air cooled vaults, and transportation elements.
- d. The building blocks were used to formulate complete systems concepts that would provide for all necessary steps with use of the available technology.

2) Financial

- a. A typical problem was set up. This problem is basically defined by a spent fuel discharge/shipment profile and by transportation characteristics. The Pacific Basin was used as a basis for stating the typical problem. This region has spent fuel discharges and transportation characteristics that are representative of other regions and has the additional problem of not necessarily having convenient geologic sites for permanent disposal.
- b. Using the Pacific Basin characteristics as typical, analyses were conducted to determine the sizing requirements of the system concepts studied. The requirements determined included number of ships and casks, required capacities of storage pools, and reprocessing plant sizes.
- c. Cost estimates were made for each of the building blocks used to develop the system concepts. These estimates were used with the sizing requirements to determine the necessary capital and operational spending profiles associated with each of the concepts.

- d. Financial analyses investigated the financing of the acquisition and operation of the system concepts and determined the necessary charges to the utilities for the service. Cash Flow Statements, Profit and Loss Reports, and Balance Sheets were developed for each concept.
- e. Variations of concept physical and financial characteristics were analyzed to provide a basis for selecting recommended concepts.
- f. Detail results of this phase of activity is documented in Volumes 3, 3A and 3B of the GSFLS Interim Report. Summary information is included in this section.

3) Final Phase

- a. Concurrent with the initial phase of the technical and financial study, other portions of the GSFLS study produced more refined estimates of spent fuel profiles for the Pacific Basin and for a European region.
- b. Results of the financial studies of the initial phase were reviewed and an assessment of the feasibility of financing the system concepts was provided. Also provided was an assessment of the probable general reaction of the financial community to the project.
- c. The many variations studied in the initial phase were reviewed along with the new profiles and the financial community assessment. Recommended system concepts were selected for further detail analysis and evaluation. The recommended concepts were selected to represent reasonable characteristics in a realistic environment.

- d. The recommended concepts were analyzed in detail to determine their financial characteristics and were also used as the basis for detailing an implementation plan.
- e. Summaries of a Pacific Basin Spent Fuel Logistics System (PBSFLS) and a European GSFLS concept are provided in Parts I and II, respectively, of this document.

3.1.3 GSFLS Spent Fuel Profile

As discussed in Section 2 (Part I), there is a need for a means by which the utilities may dispose of their spent fuel. This need translates into three phases. The near term need is to provide sufficient storage immediately to avoid shutdown of reactors whose storage pools are too full to safely accept additional discharges of spent fuel. Due to the immediacy of the near term problem, this need essentially must be met by existing facilities. The intermediate term need is for new facilities to handle the growing amount of spent fuel requiring storage. The intermediate period need not provide the final solution of the spent fuel disposal problem. However, the facilities of the intermediate period must be sufficient that enough time is provided to make the key decisions concerning the final solution of the problem. The long term phase provides the final solution to the disposal problem. The timing of these phases is shown in Figure 3.1-1.

Evaluation of global spent fuel generation and disposition patterns (see discussion in Section 2, Part I), suggests that a nominal spent fuel profile applicable to a regional spent fuel logistics system could be described by the characteristics shown in Figure 3.1-2, namely:

- System start-up would occur by 1985 $\pm$ 2 years.
- Cumulative spent fuel shipped to the regional

center by year 2000 would be approximately 20,000 MTHM. In a "deferral scenario" this fuel would likely be placed in a complex of spent fuel storage facilities.

- Cumulative spent fuel shipped to the regional center by year 2030 (end of study reference period) would exceed 100,000 MTHM. This fuel would likely be processed for energy recovery.

Figure 3.1-1: Relative Phases of the Need for Spent Fuel Disposal

Figure 3.1-2: Cum Spent Fuel Shipments - Typical Region

3.2 GSFLS TECHNICAL FRAMEWORK

The technology building blocks are sufficiently in hand to allow development of the needed spent fuel disposal system. The basic functions essential for spent fuel disposal are transportation and storage. The added functions of recovery of useful products from the spent fuel and the attendant waste management may be part of the system. Whether these latter functions become part of the system or not depends upon whether the benefits that accrue are sufficient to provide motivation to all of the concerned parties.

3.2.1 Transportation Technology

a) Casks

A relatively small number of actual casks are currently available. However, a number of designs have been developed for a variety of transportation situations including road transport, rail transport and sea transport. Several of these have been licensed and have been used in actual transport situations. There should be no difficulty in developing a standardized cask(s) for use in a spent fuel disposal system. The cask used by the GSFLS concepts in this study has the features described below. This cask is considered to be able to be designed, developed, and licensed without added research.

Description of GSFLS Standard Cask

Capacity:	10 PWR or 24 BWR assemblies (about 4.6 MTHM)
Transport Mode:	Overweight road transporter, rail transporter or by ship

Cask Weight: 100 Tons (91 metric tons)
Cooling: External Cooling System and
Dry Cavity
Shielding: Depleted uranium metal as gamma
shielding & aqueous neutron
shielding
Design: Stainless steel with impact
limiters as protection against
transportation accidents
Certification: Fully certified for a 20 year
life cycle.

b) Transporters

Transporters have also been built and used in transportation situations. No additional research is considered to be required in order to design, develop, and license a standard transporter for the GSFLS

A description of standard transporter used in this study is as follows:

Description of GSFLS Standard Transporter

Type: Standard high capacity rail car flatbed with six axles and about 60 feet in length

Modifications to standard car: Cask trunion support and fully redundant cooling systems.

Safety Provisions: Neutron shield expansion flow, anti-personnel transportation barrier, alarms and monitors. A special escort car will be provided for trains including the transporter.

c) Ships

Ship transport also has been accomplished and no added research is considered to be required prior to design,

development and certification. The characteristics of the ships used for this study are as follows:

Basic ship: Standard ocean transport of about 3000 deadweight tons outfitted to carry four casks. Outfitting to include two large cranes; devices to stabilize the ship during loading, air handling systems to prevent excessive heat build-up in the holds, and cask cooling systems.

Safety modifications: Flotation safety including double hulls, longitudinal bulkheads, and transverse bulkheads.

Added safety provisions including:

- 1) Personnel decontamination facilities
- 2) Emergency flooding and fire fighting systems.
- 3) Radwaste drains and health physics monitoring
- 4) Redundant navigation
- 5) Redundant heating, cooling, and electrical systems.

3.2.2 Receiving and Storage Technology

a) Water Basins

Water basins are currently in wide use for storage at reactors. Similar basins are also part of the reprocessing facilities that have been built. There is no doubt that similar basins could also be used in the GSFLS for temporary storage without additional development. Figures 3.2.2-1a and b show the

SECTION E-E

SCALE 1/8" = 1'-0"

SECTION F-F

SCALE 1/8" = 1'-0"

Figure 3.2.2-1b: Water Basin Receiving and Storage Modules - Sections

water basin receiving and storage facility which has been used as the reference in this study. The water basin is designed for modular expansion to keep up with any increasing demand that develops. The capacity is as follows:

<u>Item</u>	<u>Capacity</u>
Cask Receiving Facilities	5000 MTHM/year
Water Basin Storage	750 MTHM
Expansion Water Basins	750 MTHM

Alternate designs of about half of this capacity have also been developed.

b) Geologic Storage

No geologic sites are currently being used on a large scale for the permanent disposal of either LWR reprocessing waste (HLW) or LWR spent fuel. Many sites and storage media types are being studied but none have yet been qualified for such storage purposes. The most favorable at this time are salt domes and basaltic rock formations. One of these sites is located in New Mexico. Although efforts are on-going in the long term characterization of the storage media, no major developmental breakthroughs are required to implement this concept. Figures 3.2.2-2a and b show the geologic configuration used as the reference in this study. The geologic repository will include burial modules which allow emplacement of 2500 canisters or about 1000 MTHM. The burial tunnels are twenty feet wide and will space the canisters on five foot centers. This requires about 16 acres (156 canisters per acre) per module.

Figure 3.2.2-2a: Geologic Storage Facility - Plot Plan

Figure 3.2.2-2b. Geologic Storage Facility - Underground Storage Module

c) Air Cooled Vaults

The U.S. has concentrated its activities for permanent disposal on the geologic repository. However, some portions of the world may find it difficult to locate a suitable geologic formation for a repository. Technology is available for an alternative to geologic repositories in the form of the air cooled vault. No vaults have been specifically designed for LWR spent fuel but some gas cooled reactor elements have been stored in vaults. The vault concept is very simple and involves little other than static structure. Therefore, it is considered that no added research is required prior to design, development and certification of air cooled vaults. Figures 3.2.2-3a and b show the vault configuration selected as the reference in this study. These vaults, as with other storage facilities in this study, have been designed for modular expansion. These vaults are passively cooled and use the decay heat of the spent fuel to generate natural draft conditions. The spent fuel is stored in double canisters in wells around which cooling air flows. Large plenum chambers channel the entry and exit air flows. Sensors in the air stream monitor heat and radio-activity. Unsafe conditions activate an alternate fan/filter system to prevent contamination from entering the outside air. A canister transporter is an integral part of the concept. This transporter is very similar to transporters used in the geologic concept.

d) Spent Fuel Packaging

Both the air cooled vault and the geologic storage concepts require that the spent fuel be "canned" prior to final emplacement in storage. The canning

Figure 3.2.2-3a: Air Cooled Vault Receiving and Storage Modules - Plan

Figure 3.2.2-3b: Air Cooled Vault Receiving and Storage Modules - Sections

is accomplished in a special packaging facility. Figures 3.2.2-4a and b show the packaging facility configuration selected as the reference in this study. This plant is capable of encapsulating 5000 MTHM per year. A smaller size has also been investigated.

3.2.3 Recovery and Waste Handling Technology

Although there is considerable worldwide experience in recovering plutonium and uranium through the Purex separation process, there is relatively little commercial experience in recovering energy resources from LWR spent fuel and providing appropriate waste handling systems. Also, there is currently considerable global dialogue concerning the advantages and disadvantages of implementing alternative fuel cycles and energy recovery systems. In short, this study recognizes that, at this time there is no global consensus concerning the appropriateness of any particular energy recovery and waste handling technology. For GSFLS study purposes, the energy recovery system module used for cost analyses purposes is assumed to be comparable in cost and operations to a Purex type commercial reprocessing facility.

[illegible]

Figure 3.2.2-4a: Spent Fuel Packaging Facility - Plan

Figure 3.2.2-4b: Spent Fuel Packaging Facility - Sections

3.3 GSFLS BASELINE CONCEPT

3.3.1 Basic Concept Considerations

A workable spent fuel disposition system can be developed. The following considerations were used with the technology building blocks to synthesize a system as the study baseline:

- a) The study is limited to consideration of a fuel population from LWR reactors only.
- b) The global system should be made up of several regional elements. This allows the advantages of scale factor without overburdening the system with large transportation problems.
- c) The regional element should have its components co-located in an integrated center. Separation of the facilities increases costs by adding transportation and duplicate receiving facilities. Separation also multiplies the difficulties of site selection caused by possible negative public reactions.
- d) The regional element should be designed for orderly expansion and include modular or expandable elements.
- e) Currently available facilities and equipment should not necessarily be the basis of the system concept but rather the most favorable concept should be developed. Available GSFLS systems are small compared to future needs and therefore should not constrain concept development.
- f) Lead times for construction prevent immediate operation of new facilities. The earliest operational dates for major elements are considered to be:

Water Basins	beginning of 1985
Vault Storage	beginning of 1987

Geologic Storage	beginning of 1987
Recovery Facilities	beginning of 1990

3.3.2 Baseline Concept Description

The baseline concept of this report is referred to as the GSFLS Fuel Cycle Center (FCC). The FCC enterprise is formulated to handle the complete fuel population as previously defined. To accomplish this, the FCC enterprise exists and operates in three modes as follows:

a) Near Term Mode

- 1) For the near term the FCC will accomplish the following:
 - a. Receive and arrange for storage of the spent fuel which must be removed from reactor pools to allow continued safe operation. This amounts to about 1000 MTU of spent fuel and continues to 1985.
 - b. Plan and purchase new storage facilities for the intermediate term beginning in 1985.
- 2) The FCC will consist of its administrative organization and transportation equipment including ships and casks.
- 3) The FCC enterprise will contract with the utilities to receive their spent fuel. Additional contracts will be made with existing storage basins for temporary storage of this spent fuel. The FCC enterprise will accept the spent fuel and provide transport in its own ships and casks.

b) Intermediate Term Mode

- 1) For the intermediate term the FCC will receive regional spent fuel (see spent fuel profile shown in Figure 3.1-2) and place the subject spent fuel into retrievable storage facilities.
- 2) The FCC in the intermediate period will exist on a site on an island or other remote location without geologic formations for repositories. The enterprise will have the following facilities and equipment:
 - a. Ships and Casks - Ships and casks will be added to the FCC fleet as increasing fuel discharge rate dictates.
 - b. A port facility on the island.
 - c. A receiving facility and water basin - The receiving facility is of about 5000 MTU/year capacity. The water basin is a single 750 MTU pool whose design will allow addition of other 750 MTU modules if the need arises. The pool will receive and store all fuel received between 1985 and 1987. Subsequently, the pool will be used for receiving only.
 - d. Air cooled storage vaults - The first air cooled vault is available in 1987. It is about 1700 MTU in capacity and is designed for planned addition of new modules as fuel is discharged from the reactors.
 - e. Packaging facility - The packaging facility supports the air cooled vaults and can handle 5000 MTU per year.
 - f. A cask maintenance facility - This facility is available in 1985 and serves the transportation

fleet. Although not considered in the financial evaluations, expandable or modular design would provide growth of capability at least cost.

- 3) During this period the FCC enterprise will continue to receive spent fuel from the utilities but will store it in its own retrievable air vault storage.

c) Long Term Mode

- 1) For the baseline FCC the long term period begins in the year 2000. At this time recovery and associated waste management operations begin. To support recovery operations spent fuel is withdrawn from the vault storage. Waste can be maintained in recovery plant liquid storage for about 5 years. Then waste management facilities encapsulate the waste products into the spent fuel canisters. The canisterized waste is placed in the vaults for permanent disposal. While recovery operations are going on, the FCC maintains its spent fuel receiving and temporary storage operations. At the end of the study period the vaults have been emptied of the spent fuel and the storage positions have been filled with canisterized waste. The products of recovery are considered to be sold to fuel fabricators who are located elsewhere.
- 2) Figure 3.3-1 shows the plot plan of the baseline FCC complex. Figure 3.3-2 shows the variation in which recovery operations are precluded. This variation has been referred to as the GSFLS Storage Center (SC). The numerical designations

Figure 3.3-1: Baseline GSF-LS Fuel Cycle Center (FCC)

Figure 3.3-2: Baseline GSFLS Storage Center (SC)

refer to the Work Break Down Structure which has been used in the financial and economic analyses. Also shown are the dates each of the major facilities become operational.

3.4 GSFLS FINANCIAL ANALYSES

3.4.1 Baseline FCC Costs

A regional center for the disposal of spent fuel is financially feasible. The FCC which has been previously described was used as the baseline for cost analysis. Financially the FCC is considered to be a private company with private financing. Ownership is maintained by investors who organize and manage the enterprise and provide the equity capital. Additional capital is borrowed from the financial community. The FCC sets its service charge to utilities for spent fuel received to obtain a rate of return of 20%. This return is based on total project capital investments without financing and before taxes. The FCC is considered to be taxed as a private entity with an average rate of 38% after deductions and credits have been considered. The FCC is considered to have credit arrangements with the financial community such that it may borrow 2/3 of the value of any capital purchase. The loans are paid back in a manner similar to that of a mortgage at 10% interest. An added source of revenue for the FCC is the sale of the recovered plutonium and uranium. The sale price is considered to be about \$260 for each Kg of heavy metal in the spent fuel. A summary of major financial characteristics for the baseline FCC is as shown in Table 3.4-1.

Table 3.4-1
Summary of Basic Financial Characteristics
(Baseline FCC)

<u>Item</u>	<u>Amount (U.S. \$)</u>
Total Capital Investment	4.8 billion
Annual Sales (Representative year after full operation - 2015)	2.3 billion/year

Annual Net Income After Taxes (Representative year - 2015)	1.2 billion/year
Annual Taxes Paid (Representative year - 2015)	0.7 billion/year
Service Charge to Utilities for disposal of Spent Fuel	\$183/Kg fuel discharged

a) Service Charge

The utilities can afford the charge for the disposal service. The \$183/Kilogram service charge is generally quoted as being less than 1 mil per kilowatt-hour. This would not represent a significant increase in the price of electricity produced from the nuclear fuel cycle. Figure 3.4-1 shows the average sources of FCC income and its disposition. Figure 3.4-1a shows a total of 443 \$/Kilogram being received for each Kilogram of spent fuel handled. The utilities pay \$183 of this while the fuel fabricators who receive the recovered products pay about \$260. Figure 3.4-1b shows the functional distribution of costs. Note that the functions of recovery and its associated waste management cost nearly the \$260 received for the products of recovery. Figure 3.4-1c shows the disposition of income by project participant. Note here that a relatively large portion of the total costs go to the owners as the pre-tax return for equity capital.

b) Capital Financing

An industry/financial community team can afford the capital costs. Figure 3.4-2 shows funds needed for acquisition of FCC capital assets. About 5 billion dollars are needed by the year 2030. However, earnings of the enterprise are used for capital acquisition

Figure 3.4-1: Disposition of Income - Baseline FCC

Figure 3.4-2: Funds for Facility Acquisition - Baseline FCC

such that the maximum amount required from the financial community through loans is about \$2.5 billion and the maximum equity investment is about ¼ billion dollars.

c) Return on Investment

The market will allow sufficient return on investment to motivate industry. The baseline FCC considered that the enterprise would need to earn 20% on the total capital investment without consideration of financing or taxes. This produces about 20% return on investment (ROI) based on the owners investment after taxes and financing have been considered. Variations in the enterprise ROI affect the service charge as shown in Figure 3.4-3. There will be some conflict between the utilities and the enterprise owners as to what is a fair rate of return. It is concluded that there is sufficient threshold to allow an agreement to be reached. That agreement would probably settle at between 15 and 20% as fair return.

3.4.2.1 Permanent Disposal

The difference in the cost to the utilities between concepts using recovery and permanent disposal is not significant. The concept involving immediate permanent disposal is referred to as the baseline GSFLS Storage Center (SC). In its major characteristics the SC is the same as the FCC except that no recovery operations are established in the year 2000. Without recovery, it is necessary to continue adding vaults for disposal of the spent fuel discharged after 2000. A comparison of the basic financial characteristics of the SC and the FCC is summarized in Table 3.4-2.

Figure 3.4-3: Effect of ROI on Service Charge - FCC

Table 3.4-2 Comparison of Basic Financial
Characteristics - Recycle vs. Permanent Disposal

<u>Item</u>	<u>Units</u>	<u>FCC (Recycle)</u>	<u>SC (Disposal)</u>
Total Capital Investment	Billions of Dollars	4.8	8.2
Annual Sales (Representative year - 2015)	Billions of Dollars per year	2.3	0.9
Annual Net Income after Taxes (Representative year - 2015)	Billions of Dollars per year	1.2	0.3
Annual Taxes Paid (Representative Year - 2015)	Billions of Dollars per year	0.7	0.2
Service Charge to Utilities	Dollars per Kilogram of Spent Fuel	183	200

All Values based on 1978 dollar

The following may be noted from Table 3.4-2:

- a) The cost of the additional storage vaults for the SC is more than the cost of the recovery facilities, thus resulting in the higher capital investment of the SC.
- b) However, a lower net dollar return on investment is required by the SC (in spite of the higher investment). This is due to a change in the investment pattern. The changed pattern results from a relatively even spread of the investment throughout the earning period. Essentially the payback for a given vault is received within a year or two of when it is built. In contrast, the FCC requires a high front end investment by the year 2000 with earnings being returned over a 30 year period. This change in pattern reduces the dollar return required. Figure 3.4-4 shows the relative distribution of project funds between the FCC and the SC.
- c) Use of the baseline permanent disposal concept (SC) costs the utility only about 10% more than use of the baseline recovery concept (FCC). A corollary is that most of the value of the recovered products must be used to pay for the recovery and waste management facility and its financing, leaving little to be distributed to the utilities as a reduction in service charge.

3.4.2.2 Deferral of Recovery Operations

Deferral of the decision whether or not to begin recovery operations can be beneficial. Several arguments favor deferring recovery operations including:

Figure 3.4-4: Comparative Distribution of Income SC vs. FCC

- a) There is no need for recovery now.
 - 1) The quantity and the quality of plutonium and uranium in the spent fuel does not decrease in retrievable storage.
 - 2) Added facilities for storage need not increase total facility costs as

Size of future reactor pools may be reduced by the amount of AFR storage available.

Facilities constructed now can be part of the recovery facilities as was done in the baseline FCC.

- b) Risks will be reduced by deferral
 - 1) About 2/3 of the estimated need for recovery is based on projected rather than firm commitments. Deferral will allow the need for the service to more fully materialize before large investments have to be committed.
 - 2) Actual operations experience of large scale plants is not currently available. Deferral will allow development of new generation plant designs and of a high confidence data base.
 - 3) The additional time allowed by deferral could allow the regulatory agencies to stabilize those requirements having high cost impact.

To evaluate financial aspects of deferral, variations of the baseline FCC have been developed. The basic variations have differences in recovery startup times. Additional variations consider an increasing real value (about 1.2% per year) of the products of recovery. The basic differences between the variations are summarized below.

- a) Each of the recovery plants must process the complete fuel population (approximately 168,000 MTU). Each plant size was selected to operate at a base rate plus an added capacity for the backlog at startup. The base rate is the stabilized rate which occurs after reactor growth has stabilized and is about 5000 MTU/year. The resulting single plant sizes are 5000 MTU/yr for the 1990 case, 5500 MTU/yr for the 2000 case and 8000 MTU/yr for the 2010 case. The earlier startup cases will have lower total facility costs due to the use of smaller plants.
- b) With the above plant sizes, the 1990 case is penalized by having to work at less than full capacity for a number of years. To more favorably evaluate the 1990 startup case, an added variation has been included. This variation uses 2 or 3 plants coming on line between 1990 and 2000. These plants will be more fully utilized than the single plant and therefore show a significant cost advantage over the single plant. However, as multiple plant variation suffers some adverse scale factor effects, the 1990 case has a slightly higher service charge than the 2000 case.
- c) Deferral requires spent fuel storage for a longer time period. This requires more storage vaults and corresponding added facility costs. This effect occurs for the FCC as recovery starts after the year 2000. The FCC vaults are dual purpose facilities, serving initially as spent fuel storage facilities and later as waste storage facilities. The vault storage capacity required for waste is about the same as that required for the spent fuel accumulated by the year 2000. Spent fuel storage beyond 2000 causes construction of additional vaults (for spent fuel storage) that cannot be used for waste storage during the study period and are empty at the end of the period (2030). Thus the

2010 variation shows higher service charge than the 2000 variation.

Figure 3.4-5 shows the effect of deferral on the charge for service by the FCC. Figure 3.4-6 shows the distribution of income received by the FCC enterprise as effected by deferral.

3.4.3 Lack of Geologic Formation

The lack of a geologic formation suitable for a repository need not be a deterrent to establishing a disposal system as air cooled vaults can be used at reasonable costs. The baseline FCC and SC concepts used vaults as the long-term storage facilities. The vaults were used because it was considered that the baseline location on an island would not support geologic repositories and that vault technology is satisfactory to allow this usage. To evaluate the effect of vault usage, variations of the FCC and the SC with geologic repositories were established. Table 3.4-3 compares major financial characteristics. Figures 3.4-7 and 3.4-8 show the distribution of enterprise revenues.

Table 3.4-3 Comparison of Financial Characteristics - Geologic vs. Vaults

<u>Item and Units</u>	<u>FCC</u>		<u>SC</u>	
	<u>Vault</u>	<u>Geologic</u>	<u>Vault</u>	<u>Geologic</u>
Total Capital Investment (Billions of Dollars)	4.8	5.6	8.2	6.5
Annual Sales - 2015 (Billions of Dollars)	2.3	2.0	1.0	1.0
Annual Net Income - 2015 (Billions of Dollars)	1.2	0.9	0.3	0.3
Annual Taxes Paid - 2015 (Billions of Dollars)	0.7	0.6	0.2	0.2
Service Charge to Utilities (Dollars/Kg Spent Fuel)	183	135	200	202

Figure 3.4-5: Comparison of Service Charge at Varying Recovery Startup Times

Figure 3.4-6: Comparison of Distribution of Income at Varying Recovery Startup Times

Figure 3.4-7: Comparative Distribution of Income Vault vs. Geologic Repository SC

Figure 3.4-8: Comparative Distribution of Income-Vault vs. Geologic Repository FCC

As shown in Table 3.4-3, the differences in costs between concepts with vaults and geologic repositories is small.

3.4.4 Location

The location of the facilities for the spent fuel disposal system can cause a significant penalty if there is insufficient infrastructure to support construction and plant operation.

Because there is resistance to location of nuclear facilities near population centers, it is desirable to locate them where there is a low population base. This has the undesirable side effect of increased cost. The lack of a population base, the long transportation distance to the site, and lack of near-by materials and supplies increase the costs of construction. This increase can be significant. The military has constructed facilities in remote locations and has historical data concerning the increased costs. Table 3.4-4 lists some of the cost factors used by the military in locations in the Pacific Basin which are typical of remote island locations.

Table 3.4-4 Location Cost Factors

<u>Location</u>	<u>Factor</u>
<u>United States</u>	
Alaska - Aleutian Islands	3.8
Alaska - Inland, North of Aleutians	4.0
Alaska - Point Barrow	3.5
California	1.1
Hawaii - Oahu	1.3
Hawaii - Kauai	1.8
New Mexico	0.9
Washington State	1.0
<u>Pacific Islands - U.S. Jurisdiction</u>	
Johnston Islands	2.4
Line Islands - Palmyra	2.0
Mariana Islands - Guam	1.8
Mariana Islands - Saipan & Tinian	2.0

Marshall Islands - Meck	2.8
Marshall Islands - Bikini, Eniwetok	2.4
Kwajalein, Majuro	
Midway	2.4
Wake Island	2.2

Pacific Basin

Australia - Southcoast	1.1
Australia - Northcoast	2.3
Carolina Islands - Truk	2.0
Formosa - Taiwan	0.8
Japan - Northern	1.3
Korea	0.9
Philippine Islands	1.0'
Ryukyu Islands - Okinawa	1.2
Phoenix Islands	2.4

Judgement must be exercised in the use of these cost factors. It is considered that the factors are based on previous constructions that were significantly smaller in scale than the projects considered in this study and that economies of scale are possible. Also with larger constructions an incentive is provided to find lower cost construction methods such as prefabrication of major segments and transportation to the site. For this study it is considered that a factor of 1.5 should cover the increased costs associated with construction of fuel centers at remote sites such as an isolated island. An additional consideration is that one reason for sparse population is the unavailability of water. Thus location on unpopulated islands may require development of a water supply. For evaluation purposes addition of desalination plants has been considered. Figure 3.4-9 shows the effects of cost factors and lack of water on the service charge. These effects could raise the service charge by 1½ to 3 factors.

An added effect of location is differing transportation costs. Figure 3.4-10 shows the effect of transportation distance upon the service charge. The cases used in this evaluation were variations of the FCC using geologic repositories. Distance

Figure 3.4-9: Effect of Location Cost Factors - FCC

Figure 3.4-10: Effect of Transportation Distance - FCC-G

effects appear relatively small for regional concepts. Transportation between regions can mount up to 30 to 40% increase in service charge.

3.4.5 Government Participation

Since "cost of money" is a significant component within the overall GSFLS service charge, the degree of government(s) participation and its effect in "cost of money" and service charge is an important financial consideration. The baseline SC is considered to be a private enterprise existing without direct financial support by the government. Should the governments involved desire to provide financial incentives, the picture could be altered significantly. Two SC cases have been developed with varying degrees of government financial participation. The first variant considers a private enterprise which receives preferential treatment in the form of tax free status and, possibly, guarantees of financing that allow borrowing at 7% interest instead of the 10% used in previous cases. No actual government money would be required for this variant. The second variant considers a government non-profit operation in which the government provides the equity capital at 7% return and borrows long term capital at 7%. Table 3.4-5 compares the characteristics of these permanent disposal concept variations (SC) with the baseline FCC. As shown in the table, the granting of tax free status and guarantee of loans at 7% reduces the total utility service charge by \$7 billion dollars. This is about 4 billion dollars less than if private enterprise provides recovery operations. A government investment of less than 1/2 billion dollars in a non-profit concern reduces utility service charge by over 18 billion dollars. This is a more than 15 billion dollar advantage over private enterprise recovery operations. Figure 3.4-11 compares the income distribution as a function of variation of government participation.

*Table 3.4-5: Comparison of Characteristics With Variations
of Government Financial Participation*

ITEM	STORAGE CENTERS (SC)			FUEL CYCLE CENTER (FCC)
	PRIVATE ENTERPRISE	TAX FREE PRIVATE ENTERPRISE	NON-PROFIT GOVERNMENT	PRIVATE ENTERPRISE
TOTAL CAPITAL INVESTMENT (BILLIONS OF DOLLARS)	8.2	8.2	8.2	4.8
MAXIMUM PRIVATE CASH INVESTMENT (BILLIONS OF DOLLARS)	0.14	0.17	0	0.19
MAXIMUM GOVERNMENT CASH INVESTMENT (BILLIONS OF DOLLARS)	0	0	0.4	0
ROI - PRIVATE CASH %	21.8	21.8	0	21.4
ROI - GOVERNMENT CASH %	0	0	7.0	0
SERVICE CHARGE TO UTILITIES DOLLARS/Kg	200	159	92	183
TOTAL SERVICE CHARGE TO UTILITIES BILLIONS OF DOLLARS	33.7	26.7	15.5	30.8

Figure 3.4-II: Comparison of Income Distribution With Variation in Government Financial Participation

3.4.6 Fuel Profile

The financial analyses presented in Sections 3.4 through 3.4.5 have used the spent fuel profile shown in Figure 3.1-2. By using the same profile and by developing service charges on a per KgU basis the analyses provide accurate comparisons between concepts. Therefore, the comparative conclusions to be drawn from the analyses are considered valid as a general case and have been used to select recommended concepts for the Pacific Basin and for a European Region.

However, as larger plants tend to cost less per unit handled, the absolute values of the service charge may vary somewhat with the magnitude of the spent fuel profile used. To evaluate this effect, three simplified cases were developed with each case using a different spent fuel profile. The simplified cases considered only the transportation and temporary storage functions in operation through the year 2000. Figure 3.4-12 shows the effect of fuel profile on the absolute values of service charge. As shown, a $\pm 50\%$ change in the amount of spent fuel delivered produces only a $\pm 10\%$ change in service charge.

Figure 3.4-12: Effect of Spent Fuel Profile on Service Charge

The cost of a GSFLS regional spent fuel center has been shown to be large enough so that financing will be a significant consideration in establishing the project. A large portion of the required funds will be provided by the world financial community. The terms and conditions required by the financial community will serve as constraint on the development of the project. It is premature to propose specific financing at this stage of project development. However, the following provides a discussion of how such a project may be viewed by the financial community.

3.5.1 Types of Financing Available to a Regional GSFLS

There are two financing methods available to a regional GSFLS project. These are: 1) Participant financing and 2) Project financing. Project financing has two variants. In the first variant, the project itself and the credit of the participants serves as the basis for credit support. For the second variant, governments provide added credit support for the project. These financing methods are summarized as follows:

a) Financing at Participant Level

1) Description

- a. Each participant is responsible for providing its own share of the financing which will be put into the project company as equity.
- b. A capital call structure may be required to cover future requirements of the project company.

2) Advantages

- a. Simpler structure - at least initially (commercial contracts for storage).
- b. Project is financed with all equity (no need for credit support at project level).
- c. May allow some short-term financing at the project level in light of substantial equity.

3) Disadvantages

- a. May not be possible for all participants to come up with their share of the financing (e.g. lesser developed countries) in the necessary currency at the required time.
- b. A capital call structure would not guarantee that funds would be available for completion, projected expansions and/or conversion to recovery operations.
- c. Restricts capital markets in which financing destined for the project can be obtained.
- d. Increases risk to participants in event of project failure or regulatory shift that adversely affects project.

4) Other Considerations

- a. Regulatory environment relating to utilities likely treatment of expenses of storage and capital costs e.g. flow through of storage expenses, rate base treatment, etc.

b) Financing at Project Level With Government Guarantees

- 1) Description: GSFLS would be financed at the project level with appropriate government guarantees.
- 2) Advantages
 - a. Allows continuing access to all capital markets on best available terms and conditions (caveat: some limit on use of foreign government credit in U.S. market).
 - b. No problem with financing portions of project cost without completion guarantee.
 - c. Little equity required -- increases leverage.
 - d. Eliminates risk of regulatory changes on credit worthiness.
 - e. Enhances borrowing capacity of weaker participants, (includes weak government credits and all

private sector participants); governments guaranteeing could anticipate impact on borrowing capacity in certain markets (primarily U.S.).

3) Disadvantages

- a. May be difficult to obtain such long-term government guarantees (has been a problem in other situations).
- b. Guarantee may imply some form of additional government control (this may be inherent anyway in projects of this nature).

- 4) Some distinction must be made between use of U.S. and foreign government guarantees. Foreign credit would not allow same volume, rate and maturity of financing as U.S. government. May be appropriate to consider using two separate financing vehicles to separate two government guarantees and their use.

c) Financing at Project Level Without Government Guarantees

- 1) Description: GSFLS would be financed at the project level using appropriate guarantees or contractual credit supports of the participants and/or the users of the project.
- 2) Advantages:
 - a. Does not affect the credit and borrowing capacity of the participants and/or users providing the support as directly as financing on an all equity basis.
- 3) Disadvantages:
 - a. Some of the participants or users may not be sufficiently credit-worthy to provide the necessary support for the project debt, both to assure completion and for continued operation.

- b. A financing structure based on such guarantees or contractual supports would be significantly more complex than an all equity or government guaranteed structure.
- c. Absence of a financial stake in the project by governments could lead to increased risk associated with regulatory changes.

3.5.2 Credit Considerations

If project financing is to be successful, an asset must be created which can be shown to be economically viable to both sponsors and lenders. Project financing is achieved by taking this fundamentally viable economic asset and bolstering its credit standing through indirect use of the credit of the project participants. There are two types of risks associated with a project financing: completion and operation. The project's credit needs to be bolstered by the assumption of these risks by the participants. This is accomplished by contractual backup providing completion and operational guarantees. The value of these guarantees as credit support depends upon the nature of the guarantees and upon the credit rating of the guarantors.

The type of credit worthy institutions participating in the regional GSFLS could range from the U.S. government to Baa/BBB rated utilities. There is some precedent for financing foreign utilities -- particularly if they are supported by guarantees from their own governments -- in the U.S. market.

The contractual backup required to cover operational risk is typified by take-or-pay contracts for spent fuel storage. In these contracts, the utilities, or participating governments, would guarantee that the spent fuel service provided by the GSFLS would be taken or that the service would be paid for anyway. The price written into these contracts cannot be merely a fixed cost or fixed cost plus escalation. It must be a price which is sufficient at all times to cover the cash costs of the project. This

might include, for example, a relatively high price during periods of uneconomic operation, below forecast delivery of services, reduced demand, startup problems, or due to higher operating expenses or unexpected capital costs incurred during construction. These contracts should be ironclad, "hell or high water" agreements. That is, there can be no force majeure provisions which excuse performance under any conditions. In a take-or-pay contract, the price of storage would have to be payable in any and all events including interruption of operation, destruction of facilities or the inability to use the services.

The greatest project risk, however, occurs prior to the time when the storage contracts take effect. Lenders recognize that the successful completion of a project depends on a variety of factors, none of which can be predicted or effectively insured against. These factors include: technological problems, excessive inflationary pressures, unforeseen construction delays, and the inability to finance a project's capital requirements. This last concern is typically allayed to some extent by obtaining commitments for all borrowing needs at a project's construction startup. However, lenders will require firm assurances that provision will be made to meet cost overrun problems. To ensure that a project will be completed in a timely manner, lenders will insist that the participants enter into a Completion Agreement, a condition which exists for virtually every construction project financing. The Completion Agreement would obligate the project participants, or other credit worthy parties, to complete the project and usually also requires that the participants provide funds if the project is unable to raise its own funds. Typically, the Completion Agreement would also require completion within a maximum dollar amount and by a certain date which enables the project to retain its economic viability. The Completion Agreement would also

specify the lenders' exact situation in the event of non-completion of the project and subsequent abandonment, including provisions for either immediate project debt prepayment, prepayment over an accelerated time schedule, or direct assumption of the debt by the participants.

3.5.3 Capital Structure

Project financing capital structure typically differs from that of ongoing entities. This difference arises from the fact that the project can look to outside parties (the sponsors) to support its obligations in the event of unexpected problems, thereby permitting a higher degree of leverage in the project entity than is normally considered to be prudent. The amount of this leverage is a function both of the underlying economics of the project and the credit brought to the project by its sponsors. First as to the question why there should be any significant equity investment, project lenders often view 10% equity capital as an important benchmark. It symbolizes the commitment to the project by its sponsors and indicates that they have a substantial sum directly at risk. In many situations, however, depending on the quality of the credit support, only a token equity may be necessary. There are probably no particular benefits in additional equity up to 50% of the capital requirements. There would appear to be no reason to increase the equity infusion, which would simply have to be obtained from other sources -- in the case of private ownership probably borrowings that would restrict the borrowing capacity of the owners. Finally, lenders would probably view the project primarily as an ongoing entity and the liquidation value of an uneconomic or unsuccessful storage venture would not be regarded as a significant asset by potential lenders. Thus the typical "asset play" of a project lender would not be as important here as it may be in other financings.

At some debt/equity ratio (probably 50/50), the provision of additional equity begins to have a positive effect on credit. However, the requirement to provide such a large amount of equity will reduce many of the benefits to the participants of borrowing through a project entity. In addition, the need to raise the large equity portion for major projects would leave project lenders uncertain as to the ability of private or even certain governmental owners to raise these funds.

3.5.4 Equity Return

Another important issue is the determination of the proper rate of return to the equity holder. The rate structure should reflect the fact that equity funds in the project have a cost. It may not be appropriate, however, for the project to attribute a rate of return to equity as might be appropriate in a project sponsored by industrial companies. One compromise would be to use the weighted average cost of debt as the appropriate return on equity. In other words, the equity holder would earn the average of all debt holders. This figure attempts to recognize that equity capital does have a cost, but at the same time acknowledges the fact that the equity holders might borrow their equity investment, and thus it attempts to help them recoup only their cost of funds. It should be noted that since the common equity is only a nominal amount, any assumption as to its rate of return will not have an appreciable effect on the cost of storage.

3.5.5 Debt Structure

A basic premise in a financing program is the maximizing of fixed rate long-term capital. The advantage of this type of financing is that fixed interest cost allows more accurate

projections of cost for a project and substantially reduces the likelihood of widely fluctuating charges due simply to changes in the level of interest rates over the life of a given project. At the same time use of long-term obligations means that a project will not experience any significant rollover risk. In some projects, it is common to use five to eight year debt for large portions of the costs. This means that the participants must look to refinancing in the 5th to 8th year. If a project can achieve financing of 20 years or more for a significant portion of its debt requirement, this rollover risk will be minimized. It may also be an objective to establish the debt securities as obligations which are not directly tied to a particular asset. This could serve to establish a project's identity as an issuer in the debt markets, which should assist in selling debt issues for its expansion or other projects.

Relating to the question of asset protection, avoiding a mortgage for project assets is usually a goal. Mortgages are generally desired by the lenders, but cause significant administrative problems for a project and its sponsors. Thus, if the lenders can be convinced that their primary security is derived from the contracts, securities might be sold with only a "negative pledge", whereby a project entity covenants not to create a mortgage on any of its assets without securing the lenders equally and ratably.

3.5.6 Sources of Financing

The source of funding for a project is another important factor which should be examined. A number of the major securities markets and sectors could play an important part in project funding.

The U.S. Public Debt Market is an extremely large low cost source of funds. Nearly \$32 billion was raised in this

market in 1976. However, due to the complex registration requirements established by the Securities and Exchange Commission, it is generally not an attractive market for project financings, particularly startup ventures. The SEC generally requires full disclosure of financial information not only on the project but on each of the individual participants. For a multi-company project, possibly including foreign governments, such disclosures would probably be so complex as to make public registration unfeasible, at least initially.

The U. S. Private Placement Market is well attuned to lending large sums to complex startup ventures. In 1976 over \$20 billion in debt securities were placed in the United States. An additional advantage to the U.S. private placement market is the ability to commit large sums for delayed takedown over a project's construction period. As indicated earlier, this permits precommitment of all debt funds for a project.

The U.S. Commercial Paper Market is a large source of short-term funds for major corporations and some government related entities. At February, 1978, this market had outstandings of approximately \$65 billion. This market also can provide a flexible source of funds for the construction of a project, assuming that it can obtain one of the highest credit ratings. This market can be used as an interim source of funds before long-term financing or as a source of short-term funds between takedowns of prearranged long-term financing.

The Fixed-Rate Eurobond Market is a shorter term fixed rate market, with typically five to fifteen year maturities. The range of maturities is usually dictated by the quality of the credit and market conditions, with some recent issues approaching the fifteen year end of the maturity range. The Eurobond market is frequently an attractive supplementary source of funds which can be used to meet a part of a project's borrowing requirements. There are no registration requirements of the type seen in the United States, and this market is familiar

with the project financing concept, having seen multiple issues of the Queensland Alumina Project, Norpipe (a North Sea pipeline system) and Compagnie des Bauxites de Guinee (a Guinean bauxite mine). In 1976, \$14 billion in debt securities were sold in the Eurobond market.

The Floating Rate Eurodollar Market consists of eight to ten year loans syndicated to major banks. In this case, however, the interest rate is not fixed, but floats on three to six month intervals, over the London Interbank Offered Rate (LIBOR). As a result, this source does not have the advantage of fixing interest rates but rather exposes the project to continuous cost fluctuations. In 1976 there was a total of \$28.6 billion of floating rate bank loans completed.

The Japanese and Canadian markets could also be sources of funds, depending on the participation in the project, as well as other offshore dollar markets.

Additional potential sources of funds for the Project could include the commercial banks, and, where applicable, export financing programs for imported capital equipment. Although banks in the United States are familiar with project financing, this source is usually considered only for construction or secondarily for permanent financing as a result of its shorter term and floating interest programs as an export incentive. In the event that items of capital equipment must be imported, this could be an advantageous source of funds.

3.5.7 Financing Conclusions

There is a large range of financial approaches available, each with specific advantages and disadvantages. The selection of a specific financial model would be premature at this time. However, as it is necessary to have a reference for future discussions, the following general conclusions are provided:

- a) There are adequate sources to finance a regional GSFLS project, assuming an appropriate credit support structure.
- b) Project level financing probably will be used in preference to participant level financing.
- c) The lending community will require operation and completion guarantees.
- d) While guarantees by participants are possible, guarantees by the governments (particularly the U.S.) will be more desirable. Some U. S. government presence appears to be necessary. This could take the form of direct U.S. funding or guarantees.
- e) Because guarantees or government participation are required, rather low levels of participant equity investments will be required. A level of 10% equity investment would probably suffice.
- f) With government participation and low equity investments, the return on equity should be commensurate with the cost of other capital, (for example, use of the weighted average cost of debt as the appropriate return on equity). Higher returns may be justified for higher technology functions such as recovery.
- g) It would be advisable to set up a structure which would accomodate inclusion of recovery, but at the initial stage of discussion financing should be arranged for only the storage phase of the GSFLS operations.
- h) The financing structure should be kept as simple as possible, i.e., minimize the number of entities which would be financing (probably one regional and one U.S. entity).
- i) The projects goal should be to maximize fixed rate long-term financing to reduce exposure to rollover and interest rate risks.

j) It appears likely that regional governments would be called on to support a major portion of the funding for the project. Long-term fixed rate financing is not presently available in all countries or in international dollar markets. Hence the project must look to the U.S. institutional market. In that market, the foreign government's credit may support some long-term funding (depending on the country involved) but probably not in the necessary amounts, since U.S. institutional investors are restricted as to the amount of foreign securities they may purchase. Furthermore, an attempt to raise substantial amounts for foreign government's GSFLS participation would reduce its borrowing capacity in the U.S. market.

3.6 RECOMMENDED GSFLS TECHNICAL/FINANCIAL CONCEPTS

The preceding Sections (Sections 3.1 through 3.5) show that, in general, there are acceptable technical and financial basis for establishing regional spent fuel disposition centers, namely,

- The GSFLS technology building blocks are sufficiently in hand to allow development of the requisite spent fuel disposition systems.
- A regional GSFLS is financially feasible with appropriate credit support.
- The decision whether or not to recover spent fuel products can be "deferred" without significant economic penalty.

The results of the initial phase of the technical and financial activity (summarized in Section 3.1 through 3.5) were used to screen the various possible characteristics and thereby to select concepts recommended as a basis for further program development. Two concepts were selected, one using vaults and Pacific Basin logistic characteristics and the other using geologic repositories and European logistic characteristics. Results for these concepts are described and evaluated in Part II (Pacific Basin Spent Fuel Logistic System); and Part III, (European Regional Spent Fuel Logistics System). Table 3.6-1 compares selected technical/financial concept characteristics associated with the "recommended concepts" and the initial "GSFLS baseline concept" described in Section 3.3. A discussion of the rationale for changes in these concept characteristics is described in this section.

Spent Fuel Profile: During the GSFLS study visitations were made to Pacific Basin and European Countries. As a

**Table 3.6-1 Comparison of "Recommended"
and "Baseline" GSFLS Concepts**

<u>Concept Characteristic</u>	<u>"Baseline" Concept</u>	<u>"Recommended" Vault Concept</u>	<u>"Recommended" Geologic Concept</u>
Spent Fuel Profile and Transport Scenario	From Literature Pacific Basin (168,000 MTHM by 2030)	From GSFLS Visitations Pacific Basin (115,000 MTHM by 2030)	From GSFLS Visitations European Region (105,000 MTHM by 2030)
System Configuration:			
-Buffer Storage	Water Basin	Water Basin	Water Basin
-Temporary Storage	Aircooled Vault	Water Basin	Water Basin
-Permanent Storage	Aircooled Vault	Aircooled Vaults	Geologic Repositories
-Ships	4 Casks/ship	4 Casks/ship	4 Casks/ship
Recovery Startup	Year 2000	Year 2000	Year 2000
Ownership			
-Permanent Storage	Enterprise	Government	Government
-Other	Enterprise	Enterprise	Enterprise
Financing			
-Government	None	100% Financed	100% Financed
-Enterprise	2/3 of each capital item borrowed	90% of each capital item borrowed. Interest during construction capitalized at start of operation	90% of each capital item borrowed. Interest during construction capitalized at start of operation
Interest Rates			
-Government	None	7%	7%
-Enterprise	20%	10%	10%
Return on Investment			
-Government	None	7%	7%
-Enterprise	20%	Transport 12½% Temp Storage 12½% Recovery 17½%	Transport 12½% Temp Storage 12½% Recovery 17½%
Pricing	Fixed Price per KgU for all services at receipt of spent fuel	Price break at year 2000	Price break at year 2000
Value of Recovered Products	Fixed Value (260 \$KgU)	260 \$KgU in 1990 with increasing value (1.2% Increase/yr)	260 \$KgU in 1990 with increasing value (1.2% Increase/yr)
Taxes	38% of Profit	45% of Profit	45% of Profit
Location Cost Factor	1.0	1.5	1.0
Vault Costs	Baseline	Improved	Not Applicable

result of these visitations spent fuel profiles were constructed for two possible regional centers. The two new profiles were of approximately the same magnitude of fuel shipments, (115,000 MTU vs 105,000 MTU by 2030). The Pacific Basin profile was used in detailing the recommended vault concept. The European profile is used for the geologic concept.

The transportation characteristics of the two regions also vary. Pacific Basin transportation involves relatively long transportation distances (4000 miles) but uses only ship transport as both the reactors and the island site have access to port facilities. The shorter (1300 Miles) distances of the European region are counter-balanced by the need for rail transport links. Rail transport is necessary as both reactors and the geologic repositories are considered to be located inland.

The two concepts are based on specific geographic conditions. However, both concepts are considered typical of the general problem of regional spent fuel centers and the results apply generally to any region.

System Configuration: The initial phase comparison of concepts using air cooled vaults for temporary storage versus those using water basins favored the water basins. Consequently, water basins are shown for this function in the recommended concepts. One of the recommended concepts uses vaults for permanent storage while the other uses geologic repositories.

Recovery Startup: Comparisons of concepts with different startup times indicated that delay to 2000 is reasonable and this characteristic has been maintained.

Ownership: GSFLS visitations indicated a consensus that permanent disposal of waste is a problem that must be handled by government.

Financing: Review of the GSFLS concepts by the financial community indicated that government guarantees would likely be required in order to obtain financing. With guarantees most of the capital funds and the interest on construction could be borrowed.

Interest Rates: The 10% rate used in the baseline was considered reasonable for current conditions.

Return on Investment: The initial phase studies showed that service charge to the utilities was quite sensitive to the return on investment required by the owners. Government guarantees and low equity requirements provided by maximum borrowing suggests that lower ROI than used in the initial phase are reasonable.

Pricing: For comparative purposes it is necessary to develop an index of comparison. In the initial phase the index used was the average service charge. In actual practice, however, it is considered that the price would not be constant during the total period. A price break at the year 2000 (when recovery operations begin) was developed for the recommended concept. Pricing was developed as follows:

a) Transportation	Fixed price per KgU at receipt of fuel. No variation with time.
b) Temporary Storage	Fixed price per KgU for storage at receipt of fuel before 2000. Nominal handling fee (15 \$/KgU) at receipt of fuel after 2000.

c) Recovery	A fixed payment per KgU to the utility for reprocessed fuel. Paid at time of reprocessing.
d) Permanent Storage	Fixed price per KgU at receipt of fuel. No variation with time.

Value of Recovered Products: Increasing value of recovered products to account for future scarcity of uranium was used in some variations during the initial phase and was selected for the recommended concepts.

Taxes: The tax rate used in calculations was increased to more nearly approximate U.S. conditions.

Location Cost Factor: Remote locations without suitable geology has been considered to be part of the recommended vault concept. The interim study has indicated a cost penalty is associated with the location and a factor of 1.5 has been used on capital and operating costs of island facilities. The recommended geologic concept is considered to be located on a large populated land mass. The infrastructure is considered adequate to support the center and no penalty has been assessed this concept.

Vault Costs: During the design activity two studies were conducted which resulted in lower estimates for the cost of air cooled vaults:

- a) The baseline used canisters for spent fuel in the vaults. The same canister design was used for waste storage in the vaults. It was considered that the waste from 5 spent fuel assemblies could

replace each spent fuel assembly in the canister. A study of waste volumes and of cooling requirements for waste canisters indicated that the waste from 16 assemblies could be placed in the canisters. This reduces the number of canisters and vault storage spaces to a factor of 5/16 of the baseline.

- b) The baseline provided generous spacing between canister locations in the vaults. A study of the structural design of the vault suggested ways of including more canister locations per square foot of vault space. This densification reduces the amount of floor space required to a factor of $\frac{1}{2}$ of the baseline.

4.0 LEGAL AND REGULATORY FRAMEWORK

4.1 INTRODUCTION

Conceiving and planning an international spent fuel storage facility necessarily involves numerous and complex legal and regulatory issues. Both existing laws from legislation or treaty and new legal obligations in the form of agreements by participants will affect such an endeavor. This discussion will examine various legal aspects that participants will find important to consider, including the relation to existing laws which may conflict with new arrangements.

Institutions and institutional arrangements discussed elsewhere in this **report** are integrally related to legal and regulatory issues in that:

- ° Laws create institutions and provide them rules by which to operate.
- ° New institutions will probably be created under law to serve the facility (e.g. the operating corporation).
- ° Existing institutions may influence the project (e.g. IAEA).

It is impossible at this time to anticipate all of the participants' specific interests and priorities, so only general legal issues can be addressed. This review is designed to:

- ° identify legal or regulatory issues;
- ° explain their relevance;

- ° suggest a number of approaches to handling them without selecting any one approach;
- ° provide some possible guidelines for choosing among approaches.

Before any joint project can proceed far, participants must discuss and agree on a number of fundamental matters. The complexities of this venture suggest the need for a comprehensive written agreement treating as many legal issues as it is possible to anticipate. Such an agreement has the advantage of increasing certainty and thereby lessening the risk of participants failing to fully communicate their understandings of the project. Reaching an agreement and drafting appropriate provisions may be difficult, but it is essential to the success of the venture. This analysis identifies and discusses legal issues that may be involved in such an agreement, and indicates how they might be addressed by the participants. Although subsequent activities may require supplemental legal instruments, the basic agreement should anticipate and provide general guidance for any later requirements.

4.2 PARTICIPATING PARTIES

In determining who is to participate in the venture, one might consider the nature of and desirable number of participating parties ("participants"), their functions in the venture, comparative status as participants, and a method of approving participants.

Participants could conceivably be governments, private organizations, or government-private corporate hybrids. Some government involvement in the project seems probable due to the political sensitivity of the disposition of spent fuel, existing government regulatory involvement in the nuclear field, and the possible financial risk of this venture. Even if the participant from a nation is a private entity, his government most likely will wish to retain some authority over that participant's activities.

Although it is not strictly a legal problem, participants may want to consider a limit on the number of participants based upon a standard such as the region to be served or level of need. The complexity of the agreement does depend to some degree on the number of participants. Any agreement should also include provisions governing adding new parties and withdrawal of parties. (See Sec. 4.5.2(1)).

Project-related functions of participants will also need to be defined. These may include (a) hosting the project, (b) storing fuel, (c) supplying fuel to users, (d) managing the storage facility, and (e) regulating the project.

The potential exists for varying degrees of participation in the project by existing intergovernmental agencies, either regional or international, e.g. IAEA. For example, the IAEA statute allows it to serve as the operating entity by authorizing it to make provision for, acquire or establish facilities to be used in promoting the peaceful uses of nuclear energy. The IAEA could also serve as an organizing body for the venture.

Selection of a form of agreement establishing the participants' consortium will largely depend upon who the participants are, the structure desired for the resulting operating entity, and its scheme for management control. Possibilities include (a) a convention leading to a treaty, (b) an exchange of notes, and (c) a commercial contract. Participants may find a combination of these is most effective, such as an authorizing treaty followed by a more detailed private contract.

A convention is generally considered a formal instrument of agreement by which two or more nations seek to establish a relation among themselves under international law. A treaty results from it after required formalities occur. If the consortium includes governments or government agencies, a treaty is their most likely choice. A treaty has the advantage of binding a government to an agreement, which a contract would normally not do. Additionally, a treaty or convention would normally take precedence in case of conflict with existing national laws. (See Section 4.10).

However, a treaty has disadvantages also. Negotiation may be more difficult due to the formalities involved. Also, it usually requires legislative ratification, a process which could be time-consuming and complicated. Therefore, a treaty is advisable if the participants determine that (a) governments are to be direct participants such as in financing the project, (b) a new international legal entity is necessary, or (c) matters must be resolved which are handled exclusively by governments (e.g. regulation).

An alternative to a treaty is an exchange of notes or executive public agreement, which may serve to bind a government's administration to an agreement depending on national law. It could be attractive if participants are government agencies. Fewer formalities would be involved than with a treaty and such an agreement could be used in the interim while a treaty is being ratified. While the absence of a requirement for legislative ratification makes this agreement attractive for its simplicity, lack of ratification means the nation may not be bound to the agreement. Therefore, conflicts with that nation's law could become a serious legal issue and commitment of that government's funds may not be binding.

A private commercial contract to establish the project also features fewer formalities than a treaty and could be attractive if participants are private. A government agency might also sign such a commercial agreement, which would probably bind the agency (but not the government) to that agreement.

It can be anticipated based on past international nuclear activities that governments will probably take a strong role in the project. The long-term nature of the commitments to be made by the participants and the probability of conflicts between the consortium agreement and the national laws of participating countries suggest that a treaty may be the preferable form of agreement.

4.4 FORM OF OPERATING ENTITY AND ITS MANAGEMENT

The form of operating entity and management to be used will depend upon decisions regarding the objectives of the project,

the source of financing, the project's relation to external institutions, and the involvement, if any, of existing facilities.

Selection of a type of entity will require consideration of (a) matters on which prompt management responses will be required and how best to ensure such responses, (b) how best to provide for effective day-to-day operation and management, (c) the mechanism for effective control of fundamental policy decisions affecting the long-term operation of the organization, (d) the extent of authority required to perform the intended functions, (e) voting rights and (f) who owns the facility.

It will also be necessary to delegate to the manager the power to enter into contracts (within specified limits), retain and dismiss personnel, prepare and maintain accounts and supervise the handling and storage of material.

It is likely that a higher body, responsible for making policy, such as a board of governors, will be given responsibility for retaining and dismissing executive personnel, approving annual accounts, establishing rates to be charged for utilization of the facility, approving financing arrangements, recommending plans and programs in connection with the operation of the facility and generally overseeing the activities of the operating manager.

Participants may also wish to address the issue of storage by non-participants. If so, the participants will need to address such legal issues as who has authority to set

the terms of such contracts. A possible solution would be to allow the manager to set all terms except price, which would be set by the governing board. Alternatively, given the long-term commitment involved, the parties may decide to provide that the governing board must approve all such contracts. Another alternative is to allow the managing group to negotiate the contracts subject to ratification by the governing board.

Some possible organizational schemes include (a) intergovernmental, (b) private/multinational, and (c) intergovernmental/multinational. A purely intergovernmental organization may prove cumbersome to operate and therefore unresponsive to the needs of the participating parties.

A purely private multinational organization will probably lack sufficient legal authority to carry out its functions. Also, it may encounter difficulties in obtaining adequate financing if lenders perceive a risk of government policy change obviating the facility.

A mixed intergovernmental/multinational organization, perhaps with a two-tier structure could be adapted to this enterprise involving high financial commitments, sophisticated technology and national policy interests. The agreement would probably be a convention providing for a lower-tier operating enterprise having authority for management of day-to-day commercial and technical operations, and a higher intergovernmental tier such as a governing board of participating nations, with authority for policy making, and possibly regulation.

The operating enterprise can take a variety of legal forms including (a) governmental or private corporation already existing under the laws of a particular nation and subject to that nation's law except as may be provided in the intergovernmental agreement (See Section 4.10), (b) a special intergovernmental consortium whose status is defined by the agreement, (c) a corporation created by the agreement subject to the laws of a particular nation except as provided in the agreement, (d) an existing intergovernmental organization.

If an existing entity is to be used, the agreement must so state, the existing entity must have sufficient legal authority, and its managing board must adopt a resolution agreeing to perform the designated tasks. (This has been done by OECD for research activities and by IAEA and Euratom for research facilities.)

4-5 **GENERAL RIGHTS AND DUTIES OF PARTICIPANTS**

The participants must also address the legal issue of their respective rights and duties. As with other legal issues important to the parties, the subject of rights and responsibilities of participants in an enterprise is complex and as the project takes shape more detailed research will be necessary. At an early stage, however, it is necessary to have identified the more important legal issues, outlined alternative solutions to them, and provided brief guidance for choosing among alternatives.

4.5.1 Rights

Among the basic issues to be addressed by the participants in the venture are the:

1. right to participate in management;
2. right to use the facility;
3. right of ownership of spent fuel stored in the facility and right of retrieval;
4. right to receive new technology;
5. right to contract to supply related goods and services.

1. Right to participate in management.

The legal issue of what right a party has to participate in the management of the international enterprise is a basic concern. Some related questions are: does he have a seat on any managing board? How many votes does his nation have and how is the share determined? Do his rights extend to all phases of the project (e.g. design, construction, operation), or to just one phase, such as operation of the facility? Section 4.4 earlier is devoted to this issue, and develops alternative solutions for management control.

2. Right to use the facility.

Since the purpose of the proposed facility is to store spent fuel, a participant will want the agreement to define his right to do so. Some alternatives might be:

- an exclusive right with a maximum;

- an option up to a certain capacity, to be exercised by a deadline or else be forfeited;
- allowing some percentage of any storage rights to be taken from all parties in case of urgent need, after an affirmative vote of the governing board;

A reasonable provision may be a minimum capacity with options for additional capacity and flexibility to consider reducing capacity to accommodate the urgent needs of others, whether they be participants or non-participants. Capacity could be specified based on need, amount of investment, or date of application. Rights might be stated in terms of tonnes, or in terms of a percent of available capacity. A percentage may be more reasonable in the event the facility is built in stages, or additional capacity is added.

3. Right to ownership of spent fuel
stored including right of retrieval.

An important legal issue related to any storage facility concerns who has the right to control the material stored. The original owner or consignor of the spent fuel may claim some rights while the facility operator has practical powers associated with his physical control of the material. A major legal issue will be the right of the original owner or his nation to retrieve its stored fuel. Assuming title indicates the right to retrieve the spent fuel, some alternatives include:

- title retained by the original owner;
- title remains with the original owner or his nation, as they alone decide;
- title transfers to the facility owner;
- title transfers to the facility operator; and
- title transfers to an international entity.

If there is to be a shift in title, the agreement should clearly state when such an event will occur. This is because the risk of loss in the view of most casualty insurers, is on the party holding title. Alternatives might be to shift at loading from user's storage area, or at arrival at the project facility.

Alternative concepts are not to restrict retrievability at all, or else to restrict it by defined criteria, for example, bona fide need to use the energy value contained in the fuel coupled with certification that reprocessing will be conducted in an approved facility. Agreements or laws may already exist which allow the fuel supplier nation to restrict retransfer of spent fuel, such as to the project facility. Any such conflicts with participants' agreement will have to be resolved.

4. Right to receive new technology.

The legal issue concerns the extent to which a participant has the right to learn and use technology involved in the design, construction and operation of the facility. The Non-Proliferation Treaty (NPT) guarantees to its parties the right to participate in the fullest possible exchange of technical information. If the facility were expanded to include

additional fuel cycle activities such as reprocessing, the issue of the right to know-how and technological innovations becomes important. Some possible approaches are:

- to place no special limits on technology transfer;
- to limit transfer to those with a need to know;
- to limit transfer to those certified by their nation as acceptable to receive sensitive information; and
- to prohibit the transfer of sensitive technology.

The inclusion of any limits requires consideration of the NPT as well as development both of criteria and of a process to judge whether they have been met.

National patent laws and international agreements may already provide some protection against the wrongful use of ideas. However, some owners of vital technology may still insist upon non-disclosure.

5. Right to provide related goods and services.

As with the right to receive technology, the right to provide goods and services may be perceived by some participants as a valuable reason to participate. Contracts for design, construction and operation of storage facilities can be valuable. The legal issue is whether the participants, including the host nation, should be granted an advantage in providing such goods

and services. Solutions include no special arrangements, preference to some or all participants, or exclusive right to participants. Some parties may want a preference, especially if it offsets the obvious advantage in this regard of the host nation and any high-technology participants. On the other hand, a policy of no preferences is simpler to administer and could result in lower costs.

4.5.2 Duties

Balancing the agreed rights of the parties will be their agreed duties and obligations. Among these may be:

1. duty to participate for a minimum period;
2. duty to store spent fuel in the facility;
3. duty to finance the project;
4. duty at termination of the project;
5. duty to protect new technology received;
- and
6. general duty to perform obligations agreed.

1. Duty to participate for a minimum period.

The primary question here is whether the participants wish to limit their right to terminate the agreement (thus requiring participation for a minimum period) and how to provide for a participant's withdrawal. The withdrawal of a participant from the project earlier than anticipated could result in an unexpected and possibly severe hardship on the remaining parties. Providing liquidation rights and duties in the event of a withdrawal will serve to reduce the potential adverse impact of such

an act on the organization. Withdrawal may occur in one of two ways; voluntarily (either with or without the consent of the other participants) and involuntarily (i.e. at the behest of the other participants for cause, such as a failure to make required contributions). Possibilities include no requirement to continue participation, requiring participation for a period equal to the established economic life of the facility, not allowing withdrawal before the facility is closed, providing a penalty in case of withdrawal or allowing of withdrawal subject to the forfeiture of stored fuel.

A policy of not permitting withdrawal under any circumstances may be considered unreasonable since circumstances may dictate early withdrawal for one or more participants.

Since much of the damage would be financial, payment of a penalty may discourage withdrawal and may be acceptable if coupled with exceptions permitting withdrawal without penalty in certain instances. To the extent nonproliferation is the facility's objective, delayed or denied withdrawal of fuel may be an appropriate penalty. Consideration should also be given to requiring performance bonds as well as, in the case of private participants, requiring their nation's government to guarantee their performance and participation for a minimum period.

The issues to address may include: (a) procedure for withdrawal (voting rights, retention or disbursement of capital contribution), (b) effect of withdrawal (release of material, charge for continued storage), and (c) penalties. Setting out

the procedures for withdrawal may prove to be a lengthy process in itself but the effort will be justified in the event a participant withdraws.

2. Duty to store spent fuel in the facility.

The legal issue is the extent to which participants wish to obligate themselves to store spent fuel in the facility for the purpose of supporting the operation financially or for nonproliferation purposes. Solutions include being silent on the issue, requiring some fuel stored there, perhaps a percent of that discharged from the participating nations' reactors, or requiring the total output of a nation to be stored in the facility.

3. Duty to finance the project.

The financial burden to be shared among the participants must be established since it is a vital requirement for the project. Section 4.8 following describes alternative solutions as well as criteria to aid in choosing among them.

4. Duty at termination of the project.

Not being planned as a permanent disposal facility, the operation will end at some time, and the facility must be decommissioned. The question is what should be agreed about the participants' duties to contribute to this process. The host nation, to avoid being left with an expensive problem, may insist that this obligation be considered carefully and provided for in the agreement. Options include a requirement for each

participant to agree to a predetermined cash payment or to an assessment of a share of the total cost of decommissioning. A further issue concerns arrangements for disposal of the remaining fuel, a subject requiring special provisions.

5. Duty to protect new technology received.

Related to the right discussed earlier to receive new technology used in the project, is the obligation to protect it from disclosure which could harm commercial or non-proliferation objectives. Alternatives include patent laws (including the various international patent agreements), creation of a proprietary classification, or leaving the matter to the person seeking to protect the technology. Some method for classifying information will likely be needed to encourage the participants to disclose new technology to facility personnel. Patent laws are helpful, but probably not sufficient.

Appropriate controls on technology access may also need to be established in conjunction with nonproliferation objectives. Security clearance measures such as classifying documents for disclosure only to authorized persons and allowing access to certain areas of the facility only to authorized persons may be considered. Additionally, commitments may be required from participating parties limiting the use and transfer of technologies considered sensitive. Provisions may be necessary to prevent disclosure after parties withdraw from the project.

6. General duty to perform obligations agreed.

Each party to a written agreement is expected to act in accordance with it. However, a breach of the agreement may occur, and the issue is how to deal with such an event. Section 3.11 following on the subject of settlement of disputes, discusses possible alternatives.

4.6 REGULATORY REQUIREMENTS AND LICENSING

All nations likely to participate in the consortium regulate their own nuclear activities, typically in the areas of public health and safety, environmental impacts, physical security, safeguards, spent fuel possession, transportation, import and export, and third-party liability. To conduct these activities, licenses are usually issued by the competent government authority according to its established requirements. Siting is usually regulated as well and is discussed in Section 5.

Uniform international guidelines have been adopted by such nations for some of these areas including third-party liability, safeguards and transportation. In transportation, for example, most nations have based their laws on guidelines issued by the IAEA entitled "Regulations for the Safe Transport of Radioactive Materials", Safety Series No. 6 (1973). In any event, the participants may wish to provide for non-interference by the host nation of shipments to and from the facility. For the remaining regulatory areas, the present legal regime consists of non-uniform national laws which may differ significantly in vital aspects.

The legal issue the parties must address is what regulatory scheme should govern the storage facility. In those areas for which international guidelines have been adopted, the choice is not difficult. But for the remaining areas, constituting a major portion of the regulatory scheme, national laws differ and selection thus becomes more difficult. Alternative solutions include using the host nation's regulatory scheme, establishing a separate scheme in the agreement, or some combination of the two solutions.

As it is already in existence, the host country's regulatory scheme has certain advantages. Use of an established regulatory scheme saves the participants from having to draft their own regulations, a complex and lengthy undertaking. Furthermore, the participants would have the advantage of knowing in advance the regulatory regime which will govern and may be able to anticipate, and thereby avoid, potential problems. If the participants decide to draft their own regulations, it could lead to endless negotiations with no assurances that the resulting regulatory scheme will be a coherent whole. Even then, a period during which the regulations are applied will be necessary before the participants fully comprehend the ramifications of such regulations. Another advantage of using the host country's regulatory scheme is the possibility of obtaining greater acceptance of the project in that nation; that is, there may be greater opposition in the host nation to an international facility which operates outside laws designed to protect the public from nuclear activities in that nation.

On the other hand, use of the host nation's regulatory scheme may present certain difficulties which could be avoided by specifying a special scheme for the facility. Opponents of nuclear facilities in the host nation may have successful methods, under their law, of delaying or defeating proposed projects. Thus, the project could be blocked in the host nation, and the parties, once having agreed to be bound by host nation law, may be powerless to proceed with the project there. Of course, any proposal that the facility be immune from host nation regulation is also likely to be resisted by the same nuclear opponents.

A compromise may be necessary. In order to obtain public acceptance in the host nation, compliance with some of the host nation's laws may be required. A compromise could take the form of an agreement to use best efforts to design, build and operate the facility in compliance with host nation laws and according to guidance from its regulatory body. However, the facility would not be required to submit to host nation operating laws, license requirements and appeal process, and no licenses would be required for the facility. The operator thus would retain the flexibility to choose whether to agree to certain procedures, such as public hearings, or to avoid them.

As noted elsewhere in this discussion, the participants may decide to require themselves to use the facility for non-proliferation purposes, as well as to support the project financially. Although unlikely, such a provision could raise the legal issue of restraint of trade by parties unable or unwilling to participate, or who wish to later accede to participation but are denied entry.

If there is governmental participation in the venture "antitrust" aspects should be alleviated. If there is no governmental participation or intergovernmental agreement, then the participants will have to be more concerned about these and other possibly anticompetitive acts. It should be noted that antitrust legislation exists in a number of jurisdictions including the United States and the European Economic Community. If participants conclude a treaty, one solution would be to include an antitrust exemption.

4-7

NONPROLIFERATION

Nonproliferation goals may play an important role in shaping the policy and structure of the project. As a legal issue, nonproliferation obligations provided in the agreement will have to be precisely defined. The Nonproliferation Treaty (NPT) and subsequent bilateral treaties between NPT nations and IAEA already impose safeguard obligations on some participants. The obligations of participants in the project who have not signed the NPT will need to be established.

Facility inspection procedures must be agreed, such as standards and methods. IAEA's established safeguards system could be adopted to regulate accounting for nuclear materials, alleviating the need to establish a new system.

A related issue concerns physical security requirements which user nations participating in the project will need to or will want to observe.

Another legal issue to be settled is the financial obligation of each participant. The answer may depend on the nature of the participant. There are several categories of participants that may be involved in financing the facility including (a) governments, (b) private spent fuel owners, (c) other private entities, or (d) some combination of these.

Since financial risks of the venture may be large and depend in part on public policy, participants may conclude that governments will have to play a particularly active financial role. Government financial involvement could include direct supply of funds, loan guarantees and approval of electric power rate adjustments. The participants will have to decide whether the facility is to be self-sustaining or subsidized.

Participants may agree to assist in the financing of the facility by partial prepayments for future services, direct equity investments, and debt financing. In addition, should any of the participants be equipment suppliers as well, the provision of supplier credits may be required.

Outside financing may come from diverse sources such as floating long-term loans (e.g., bonds, commercial paper) on capital markets and export credits for the purchase of equipment.

The financial burdens of the facility will have to be allocated among the participants. Major issues with respect to this aspect of the operation include (a) assessment

of the contribution to be made by the respective participants and whether any special considerations are to be given to a host State, (b) effect of the failure of a participant to contribute, (c) the method by which extraordinary financial needs will be met, (d) exemption from tax and custom duties for the equipping and operation of the facility, (e) provision for re-allocation upon admission of new participants, and (f) procedure to finance any cost overruns.

Finally, any financial benefits derived from the operation of the facility will have to be allocated among the participants. This may be done on the basis of capital contribution or use.

4.9 **THIRD-PARTY LIABILITY**

A third-party liability regime, to provide for compensation in case of injury to the public from project activities, is a legal issue participants should address in the agreement. The host nation may insist on such provisions since any injuries will most likely be to its citizens from activities at the facility. On the other hand, any injuries from transportation would likely take place outside the host nation.

Among other details, the participants should decide whether to provide absolute liability, meaning compensation regardless of fault, and exclusive liability, meaning no person other than the operating entity is liable. Submitting to these obligations may be desirable to increase support of the public and the host nation for the project.

The issue of whether to place a monetary limit on liability will also have to be considered. This concept can be regarded as a counterpart to the acceptance of absolute liability. If the operating entity's liability were unlimited, it might be unable to find corresponding financial security by insurance or otherwise. Furthermore, the possibility of obtaining private financing might be substantially reduced. Therefore, if the concept of absolute liability is accepted, there should probably be some limitation.

The participants may wish to establish a fund for financial security with respect to potential third-party liability. This will encourage the issuance of insurance policies by private insurance companies and, to an extent, placate the legitimate risk concerns of private lenders.

The participants may also consider providing for a single body to adjudicate actions on third-party liability from project activities. Since claims would be consolidated, this would ensure that any limitation of liability is not exceeded and that any compensation is equitably distributed. The court system of the place of injury generally is competent to settle the issue. But there should also be provisions determining jurisdiction if an incident occurs wholly or partly on the territory of another nation or when there is uncertainty as to where the incident occurred. The participants should also consider guaranteeing enforcement of final judgments entered by the competent court.

Some possible solutions are to adopt the host nation's liability regime, or to adopt one or more of the international third-party conventions. They include The Convention on Third-Party Liability in the Fields of Nuclear Energy (Paris Convention), the Convention Supplementary to the Paris Convention on Third-Party Liability in the Field of Nuclear Energy (Brussels Supplementary Convention), the Vienna Convention on Civil Liability for Nuclear Damage, and the Convention relating to Civil Liability in the Field of Maritime Carriage of Nuclear Material (IMCO). The U.S. liability scheme, created under the Price-Anderson Act, provides another model.

4.10 APPLICABLE LAW AND RELATION TO NATIONAL LAW

The agreement of the participants may contain provisions which conflict with existing law, may require additional legislation by participants, and in any event will require participants to choose which legal system will govern the agreement. The legal issue is how to reconcile this in the agreement.

As to conflicts, host nation laws are those most likely to be in conflict, because most of the project's activities would take place in that nation. But national laws of any of the participants could also be in conflict with the agreement.

If the agreement reached is intergovernmental, such as a treaty, ratification of it by a nation's legislative body should resolve any conflicts in favor of the treaty provisions.

If the agreement is not a treaty, to avoid having such conflicts frustrate the intent of the participants, provisions in the agreement should rank at least pari passu with host nation laws and preferably state the intent of the participants that the agreement take precedence. But special legislation by participant nations may still be required to avoid conflicts.

Implementing national legislation may be required for several purposes. It may be necessary to obtain continuing financial appropriations to support the facility, annually or as and when necessary. Government participants will have to agree to this obligation, and propose necessary legislation. Also, to the extent the agreement is not self-executing it may be necessary to obtain legislative consent to the transfer of the material to the facility and to the release thereof.

With the host nation, the participants may request legislation, for example to ensure privileges and immunities of the facility. This might include a tax exempt status (custom duties and income taxes) and a degree of immunity from lawsuits. In other areas, the participants may want the host's laws to apply. Examples might be local labor laws, certain laws governing the ownership of property, police and fire protection, and other laws regulating relationship of host nation citizens or expressing strongly held public policy notions. Potential conflicts with laws regulating nuclear safety, environmental protection, third-party liability, and transport and the storage of nuclear material, have been discussed previously in Sections 4.6 and 4.9.

At some point during the term of the agreement a dispute will probably arise between participants. Therefore, it is important that the agreement set forth a mechanism for the prompt resolution of the dispute. The need for such a mechanism exists whether the parties are governmental or private, and regardless of the form of the agreement.

There are a number of possible approaches which may be considered including (a) a particular national judicial system, (b) an arbitral body (either presently existing or specially constituted), (c) an international body formed for the purpose of disputes resolution.

The advantage of using a particular national judicial system is a reasonable possibility of predictability of result. The primary disadvantage is that a party having a different nationality will likely be unfamiliar with the particular system and therefore unwilling to accept its use without careful study. The main advantage of utilizing an arbitral body is the informality of the procedure (hopefully leading to speedier decisions) and the opportunity of participants to appoint arbitrators with recognized expertise in the field.

It is also possible to establish a dispute settlement body in the agreement. Such a permanent mechanism avoids the numerous difficulties which arise when, for example, a party refuses or fails to appoint an arbitrator. The cost of this type of mechanism may be an argument against its use. An

alternative would be to agree to a list of acceptable arbitrators at the outset of the project and appoint some impartial authority to empanel an arbitral tribunal from among those.

Disputes may also be referred to an international entity such as the International Court of Justice or the International Centre for the Settlement of Investment Disputes.

Due to the high technology involved, it may be preferable for the parties to establish a disputes settlement mechanism separate from any national or international body. If the parties so decide, they will need to determine (a) the number of arbitrators to be empaneled, (b) the time within which nomination of arbitrators is to take place, assuming that there is no standing panel, (c) the qualifications of the arbitrators, (d) the scope of the disputes settlement (i.e. subject matter jurisdiction), (e) the procedure to be followed by the body, and (f) the applicable law to be followed by the panel.

5.0 GSFLS SITING CONSIDERATIONS

The successful implementation of multinational spent fuel storage concepts rest on the identification of acceptable siting alternatives. The notion of acceptability encompasses technical, but more importantly, institutional considerations.

Technical considerations have initially preempted other concerns in the definition of adequate spent fuel storage concepts, reflecting a genuine preoccupation for solving the widely differing requirements associated with interim or permanent storage options. The technical aspects for storing spent fuel in surface or sub-surface conditions have been the subject of discussion for some time, and systematic siting criteria are currently developed by many countries. Criteria development has addressed specific physical conditions (mainland, island environments, and deep sea trenches), the specific nature of projects (interim or permanent storage), and their functional relations with other possible activities in the backend of the fuel cycle (co-location requirements for reprocessing and permanent storage, for instance).

So far, the study effort has examined the accumulated research to date relative to criteria definition for specific environments (e.g., tropical island ecosystems) and applied the set of criteria parametrically to a few cases in the Western Pacific region for screening purposes. The results of this preliminary, and narrowly focused investigation confirm the latest developments on the subject: While technical difficulties may not be unsurmountable (at extra costs), institutional constraints could easily become so, and appear (in this case) to be the single most important factor in the site selection process. This indication holds true whatever the nature of the project - be it interim or permanent storage.

This bears important planning implications for the development of multinational arrangements in the Pacific Basin.

First, this indication should eliminate any tacit attempt in the future to analytically address the technical difficulties before exploring the institutional constraints of the siting alternatives involved in a future multinational arrangement. Second, given both technical and institutional constraints, it appears that a permanent storage concept cannot be implemented in the Pacific Basin before the long term (year - 2000) horizon. This confirms the need for an AFR storage option that would allow an adequate holding capability for the bridging period.

Consistent with this trend, some careful generalizations could be made for the European case. Although the study effort has addressed the storage issue on technical grounds, the visit findings in Europe clearly demonstrate that institutional factors are critical to the development of both permanent and AFR programs. The institutional aspects of the permanent storage issue are so critical that the pursuit and development of important nuclear programs (e.g. Sweden and Switzerland) are in jeopardy. This is all the more significant since Sweden in particular was able to develop (technically) a permanent storage concept in granitic formations.

It appears therefore that the planning recommendations for shaping spent fuel arrangements in Europe should respond to the following logistical requirements and (1) seek acceptable AFR sites that could become operational at the earliest possible time, and (2) make a definite preference for those AFR sites that could expand into permanent storage activities, and (3) commit the parties in the arrangement to find viable permanent storage alternatives.

Host country qualifications for establishing a multinational spent fuel storage facility (with possibilities of serving other fuel cycle functions) include the following:

- The host country should be free from risk of terrorist, military or insurrectionist attack, or seizure by a foreign country.

- The host country nonproliferation credentials should be above suspicion. There should be no perception by other participants that the host country has an interest in acquiring nuclear weapons through the facility's existence. Accordingly, at a minimum, any non-nuclear weapons host country should be a party to the NPT, with all its fuel cycle activities under IAEA safeguards.
- Nuclear weapons countries would be the most secure sites because these countries have already demonstrated possession of weapons-usable material and should have little incentive to divert materials, except for use as a fuel.
- A non-nuclear weapons state which is a party to the NPT may be just as qualified from the perspective of lacking nuclear material diversion incentives.
- Countries which already possess reprocessing facilities should receive positive siting consideration because they would have little interest in diverting material from an international facility.
- A third world country could possibly be considered as a host country, providing the country demonstrated appropriate nonproliferation qualities, including a record of political stability and maturity and appropriate international controls were applied.
- Islands or other remote locations have a number of advantages, including the ability to limit the number of access points, such that diversion of material without detection might be difficult.

- Extraterritorial areas, in which the extraterritorial zone and rights were carefully guaranteed in treaty provisions, would be a positive consideration for siting. There would not be the possible frustration of the objectives and functions of the system through actions of a host country exercising its sovereign powers - short of actual takeover - for instance, by harassing the facility staff or its inspectors. An example of this approach might be for a donor state to cede a small portion of its territory - or perhaps an island - to the consortium or to an established organization like the IAEA or the U.N., with the understanding that it could be utilized exclusively for the fuel cycle purposes intended.

1.0 INTRODUCTION

In conducting the study, visits have been made by the contractor team to a number of Pacific Basin countries with significant nuclear power programs for the purpose of collecting both technical data on spent fuel discharges and information on national policies and plans relating to the disposition of this material. The collected information has been analyzed by the study team and a preliminary research concept has been developed as a recommended Pacific Basin Spent Fuel Logistics System (PBSFLS). The purpose of this concept definition is to identify the technical and institutional factors associated with a regional spent fuel storage activity serving Pacific Basin countries.

The purpose of Part II of this report is to summarize the conceptual framework of a Pacific Basin Spent Fuel Logistics System (PBSFLS) as perceived by the study team and to preliminarily indicate key programmatic steps that might be taken in order to implement the recommended concept.

The scope of this report includes the following:

- a) Delineation of the basis for a Pacific Basin Spent Fuel Logistics System (PBSFLS) including objectives, constraints, key decisions/scenarios and requirements for a PBSFLS.
- b) Description of a "preferred" PBSFLS conceptual framework in terms of technical system description, organizational architecture, siting considerations, legal/regulatory framework, and financial concept.
- c) Identification of key program implementation requirements including program funding, key institutional events and principal technical activities.

2.0 BASIS FOR A PBSFLS

2.1 INTRODUCTION

There appears to be a need to put in place a Pacific Basin Spent Fuel disposition system that can achieve the following objectives:

- provide an interim LWR spent fuel storage solution that reduces pressure to prematurely reprocess as a means of spent fuel disposition
- adjust to technical and institutional nonproliferation solutions as they are developed and accepted globally
- meet long-term energy resource needs of participants
- solve long-term waste management needs

The regional spent fuel logistics system described in this report is designed to (a) emphasize strong Japanese/U.S. roles and ties; (b) allow participatory opportunities for other Pacific Basin countries; and (c) utilize regional strengths and economies of scale. The "preferred" PBSFLS concept incorporates the following scenario:

- Spent fuel is shipped from Japan, the U.S. (portion of the U.S. away-from-reactor spent fuel disposition load); and other Pacific Basin countries to a "least cost" interim storage facility located within the Pacific Basin region.
- Spent fuel is shipped to the PBSFLS from 1985. In the late 1980's a favorable decision is made with respect to proceeding with energy recovery of the cumulated spent fuel.
- An Energy Recovery plant is constructed during the 1990's and begins operation in the late 1990's. Correspondingly a long-term storage program is initiated in the late 1990's and receives the waste material for the Energy Recovery operations.

This section describes the objectives, constraints and key decisions, scenarios, and requirements for a PBSFLS.

2.2 IDENTIFICATION OF KEY CONSTRAINTS AND OBJECTIVES FOR SHAPING A SPENT FUEL ARRANGEMENT IN THE PACIFIC BASIN

While Pacific Basin nations have had an interest in reprocessing, Japan is specifically concerned with developing a commercial breeder reactor program before the end of the century. With the highest energy import dependence of any major industrial nation, Japan sees the breeder as an essential element in the development of a strategy to reduce this dependence. The fact that by the end of the century reactors in the Pacific Basin will have discharged spent fuel with a cumulative fissile plutonium content in excess of 200 metric tons, enough to start up over 40 GWe of breeder reactors, may become a factor in the energy policy of the Basin countries, and especially in Japan. The predominance of Japanese spent fuel to the end of the century in concert with the Japanese interest in national reprocessing, makes Japan the critical Western Pacific nation influencing a basin spent fuel arrangement. The participation of the remaining Western Pacific nations having spent fuel disposition requirements is of course very important.

An analysis of the fissile plutonium requirements of the Japanese breeder program provides insight as to the possibilities for a reprocessing deferral scenario associated with the Pacific Basin Spent Fuel Logistics System. The principle of the basin concept is to defer reprocessing until required for breeder commercialization. In this analysis, the fissile plutonium requirements of the Japanese breeder program are

projected and compared with the LWR spent fuel projected to be discharged in Japan and the Pacific Basin. The analysis takes into account the fact that the Tokaimura reprocessing plant has begun operation and assumes for the purpose of the analysis that BNFL and COGEMA contracts are consummated to reprocess 4,550 MTHM of spent fuel for Japan by 1992. Further assumptions are that the October 1977 FBR schedule of the Japanese Science & Technology Agency will be achieved and that nuclear power will grow to 90 GWe in Japan and 117 GWe in the Basin by the year 2000. A finding is that the bulk of Japanese LWR spent fuel to year 2000 would be required to support the plutonium demand for the Japanese October 1977 FBR schedule, leaving insufficient plutonium for full scale LWR recycle in the same time frame. The analysis indicates that additional reprocessing capacity (beyond Tokaimura and the existing BNFL/COGEMA contracts) would not be required until the late 1990s.

The foregoing indicates that Japan may require development of a long term FBR and associated reprocessing program, to be operationally implemented by the mid-to-late nineties. Until it is operationally underway, there will be an increasing demand for spent fuel storage capacity in the Pacific Basin. However, this demand would tend to peak in the period 1995-2005.

Therefore, even on nonproliferation grounds, a Pacific Basin arrangement cannot foreclose the ultimate possibility of reprocessing or breeder commercialization activities

for Japan without jeopardizing the chances of success for such an enterprise.

In addition to relieving Japan from an immediate pressure to reprocess, a regional spent fuel facility arrangement would initiate an institutional mechanism, which by its own dynamics, will directly support the nonproliferation objectives in the Pacific Basin. The present situation is such that the burden of proof rests with those with nonproliferation concerns. Those parties must demonstrate to Pacific countries that their expected social costs for reprocessing exceed their expected social benefits. The present inertia of the international system plays against nonproliferation objectives in the basin. In the considered spent fuel storage approach, the country that would decide to retrieve its residual fuel values would have to demonstrate to the rest of the community that its expected social benefits would, at that point, exceed its expected social costs. The burden of proof would have exchanged sides, and the inertia of the international system would then work for nonproliferation objectives in the Basin.

In summary, a nonproliferation strategy designed for the Pacific Basin should not foreclose the reprocessing option, but could (1) delay the decision to reprocess as much as possible, (2) provide a congenial basis for a multinational reprocessing venture (as opposed to a national option), (3) secure the optimal nonproliferation posture if/when Japan decides to reprocess, and (4) provide an acceptable basis for agreement for all the concerned parties in the Basin.

2.3 KEY DECISIONS AND SCENARIOS

The consideration of a Pacific Basin Spent Fuel Logistics System provides an opportunity for participants to assess reprocessing deferral decisions under conditions which might be responsive to their special interests and needs. With that understanding, the research effort has outlined assumptions on "key decisions and scenarios" for planning and analysis purposes.

The approach of the multinational consortium is to implement a regional interim spent fuel storage program for participant Pacific Basin nations which would serve as an alternative to the concept of early reprocessing as a means of spent fuel disposition and would support reprocessing deferral decisions.

The key scenario involves participant nations agreeing to place normal overflow spent fuel discharges from reactor plants in a "least-cost" regional interim spent fuel storage facility with a commitment to deferral of early reprocessing. The capacity of the interim storage facility would accommodate cumulative spent fuel discharges through year 2000.

During the holding period from now to year 2000, the participant nations would agree upon nonproliferation and energy conservation criteria related to the balance of the fuel cycle and would make longer term spent fuel disposition decisions by the mid-1980s for implementation by year 2000 or other date as defined by criteria. The decision making by the mid-1980s would include three basic options:

- o Decision to reprocess/recover

Scenario:

- If decision affirmative, decide on HLW storage (interim or permanent).

- Continue to install least-cost interim storage capacity to hold fuel for future reprocessing/recovery; to act as receiving buffer for reprocessing/recovery; and to provide interim storage for HLW if required.
- Permanent storage for HLW (and any spent fuel not to be recovered) to be developed if required by earlier decision.
- Reprocessing/recovery facility developed by year 2000 (or other date as defined by criteria) with co-location preferable.

o Decision to continue surface storage

Scenario:

- Decision for extended surface storage to accumulate spent fuel generated up to year 2030.
- Shift new storage additions from least-cost interim storage to long-term surface storage capability.

o Decision to dispose of spent fuel permanently

Scenario:

- Decision for permanent disposal to be implemented by year 2000.
- Interim storage to be phased down to act as buffer for permanent disposal.

2.4 PBSFSL REQUIREMENTS

The PBSFSL is considered to receive spent fuel generated from the following national sources:

- a) Japan
- b) U.S.
- c) Other Pacific Basin countries such as the Republic of China, Republic of Korea, Phillipines, etc.

The perceived range of spent fuel capacity requirements for a PBSFSL is shown in Figure 2-1. Two basic spent fuel requirement "bands" are shown. The make-up of each spent fuel "band" is described below.

"Lower Band"

The "lower band" is derived for the following assumptions:

- a) Japan ships its residual AFR disposition requirements to the PBSFSL after shipping 4550 MTHM to BNFL/COGEMA (up to 1992) and reprocessing 210 MTHM per year starting in 1980.
- b) The U.S. ships 25% of its AFR disposition requirements (after 1985) to the PBSFSL.
- c) All other Pacific Basin countries ship all of their AFR disposition requirements to the PBSFSL.

"Upper Band"

The "upper band" is derived from the following assumptions:

- a) Japan ships its residual AFR disposition requirements to the PBSFSL after shipping 1350 MTHM to BWFL/COGEMA (up to 1984) and reprocessing 210 MTHM per year starting in 1980.
- b) and c) are the same as above.

The spent fuel shipped to the PBSFSL is shown as a nominal profile within the two "bands", and is considered to be as follows:

	<u>Cum spent fuel (1000 MTHM)</u>
1990	4
2000	22
2030	115

PBSFLS Spent Fuel Profile

Figure 2-1

2-8

In order to satisfy the rationale that (a) interim storage is to be provided until 2000 and (b) energy recovery is to begin in 2000 the following storage and recovery facility requirements are needed.

	<u>PBSFLS Requirements</u>
<u>Peak Interim</u>	22,000 MTHM (yr. 2000)
<u>Storage Capacity</u>	
<u>Energy Recovery</u>	3700 MTHM/yr.
<u>Plant Capacity</u>	

Figure 2-2 shows the corresponding PBSFLS transportation requirements.

PBSFELS Transportation Requirements

- **CASKS:**

- 10 PWR OR 24 BWR ASSY.
- (4.6 MTHM CAPACITY)
- 85% UTILIZATION

- **SHIPS:**

- 3000 DWT
- DOUBLE HULLED
- LONGITUDINAL AND TRANSVERSE BULKHEADS
- REDUNDANT OPERATIONAL EQUIPMENT

- **TRANSPORTATION:**

- ABOUT 4000 STATUTE MILES
- AVERAGE SPEED 16 MPH
- ABOUT 1½ DAY TO TURNAROUND FOR SHIP

Figure 2-2

3.0 PREFERRED PACIFIC BASIN SPENT FUEL LOGISTICS SYSTEM (PBSFSL) CONCEPT

3.1 INTRODUCTION

Section 2 established the basis for a PBSFSL in terms of the underlying rationale, key decisions/scenarios and requirements. In the course of the GSFSL study, various concept alternatives and sensitivities inherent in a PBSFSL have been examined. As a result of this evaluation, the team has selected a concept referred to as the "preferred" PBSFSL concept for additional study. The "preferred" concept, which is described in this section, has been selected to best:

- a) meet national, regional and global interests and concerns
- b) use available technology
- c) provide for appropriate organizational architecture
- d) provide for acceptable financial structuring

It is recognized that the preferred concept may vary from that which finally emerges if a PBSFSL project is undertaken. However, its formulation at this point allows a lower level of detail to be developed for the study than would otherwise be possible. Also, discussions with both U.S. and Japanese agencies can be more detailed and therefore more productive. A detail description of the preferred concept is provided in the following sections.

3.2 TECHNICAL DESCRIPTION OF PREFERRED PBSFSLS CONCEPT

Figure 3-1 shows the layout for the preferred PBSFSLS concept. The PBSFSLS site is considered to be located on an island in the Pacific with an average transport distance from fuel generation sources of approximately 4000 miles. Operations begin in 1985 with 2 ships and 15 casks providing the transportation link. The ships are about 3000 dead weight tons and carry about 4 casks. The ships have been modified to provide double hull safety. The casks are large rail transport size casks with capacity for 10 PWR & 21 BWR fuel elements. The PBSFSLS begins 1985 operation with a receiving facility, a single water basin, and supporting facilities. During operation the ships arrive at the center port facility and unload their casks. The casks are transferred by a tug and a rail car to the receiving facility where the casks are unloaded. The spent fuel is then transferred to the water basins and the casks are returned for future trips. Operations continue in this manner from 1985 to 2000. New ships, casks, and water basins are added to keep pace with the spent fuel shipments. By 2000 the expected PBSFSLS complement includes 14 ships, 71 casks and 19 water basins (1025 MTHM each). Following the decision in 1990 to proceed with recovery and waste disposal, new facilities are constructed and begin operations in 2000. These facilities include a recovery plant, waste management facilities, waste canisters, a packaging facility and air cooled vaults for permanent disposal of waste. During operation, casks are transferred from the receiving facility to the recovery plant. The recovery plant (3700 MTHM/YR) has capacity that is somewhat larger than the spent fuel receiving rate thus allowing for drawdown of the spent fuel in the water basins. Waste from the recovery operations is solidified and packaged into canisters. The canisters are about the same size as spent fuel assemblies, thus allowing for their transportation in spent fuel casks should the need arise and also allows the air cooled vaults to be used for either spent fuel or canisterized waste as required.

While the preferred concept uses the air cooled vaults for waste storage two other options are possible without significant penalty. The first option includes selection of a PBSFSL location with suitable geology and use of geologic repositories in place of the vaults. Figure 3-2 shows the layout of a PBSFSL site incorporating a geologic repository. The other option is to select a site without suitable geologic formations and using a non-located geologic repository.

Figure 3-1

3-4

PLOT PLAN
SCALE 1" = 160'-0"

Layout of Alternate Concept with Geologic Repository

PLOT PLAN
SCALE 1" = 100'-0"

3.3 FORMATION AND ORGANIZATIONAL ARCHITECTURE FOR A PACIFIC BASIN SPENT FUEL CONSORTIUM

The development of alternative concepts for a Pacific Basin spent fuel consortium incorporates four steps as follows: (1) Characterize the working environment of the future consortium by defining key nonproliferation, business operations, and financial strategy criteria. (2) Identify candidate institutional models that have proved to be successful, that will represent viable alternatives for a Pacific Basin arrangement, and will satisfy the three sets of criteria defined above. (3) Identify preliminary organizational options that build upon the pertinent features of the candidate models. Finally (4), propose an organizational architecture for the consortium that will satisfy all above considerations.

3.3.1 Major Criteria

In defining the working environment for a Pacific Basin spent fuel arrangement, three sets of criteria dictate the successful implementation, operation, and growth of a Pacific spent fuel consortium: (1) nonproliferation criteria, (2) business operations criteria, and (3) financial strategy criteria.

3.3.1.1 The Identification of Nonproliferation Criteria

As mentioned previously, the values or considerations (positive or negative) of significance to the development of a Pacific Basin spent fuel arrangement are:

- (1) Relief of pressure for premature fuel movement into a reprocessing system
- (2) Reduction of incentives for national fuel cycle activities, including national reprocessing
- (3) Unwanted technology transfer

- (4) Possible deemphasis of proliferation concerns and safeguards
- (5) Host country takeover problems
- (6) Host country cessation or slow down of fuel cycle functions
- (7) Increased safeguards risk in transportation

All such imputed values or considerations are essential to the shaping of a Pacific Basin spent fuel concept. Consideration (1), however, is of critical importance and preempts all other nonproliferation values or preferences for the successful implementation of any strategy option in the Pacific Basin.

The suggested objective for a Pacific Basin arrangement is to provide:

a means of storing LWR spent fuel so as to reduce the pressure to prematurely reprocess as a means of spent fuel disposition.

This institutional strategy takes into account Japan's objective to operate an LWR fuel cycle while proceeding rapidly towards breeder development and deployment. Japan is capable of indigenously manufacturing most nuclear plant components, as well as having a highly successful nuclear RD&D capability (i.e., the Tokai pilot reprocessing plant and the Joyo 60MWe LMFBR). However, there is a research assumption that (1) Japan would not oppose international spent fuel arrangements if it were assured of receiving equal treatment with Western nations; (2) the Japanese utilities would be receptive to spent fuel storage programs if provisions were made to release the fuel when needed pursuant to agreed upon conditions, such as to support breeder RD&D or commercialization programs; and (3) the minor countries would incline toward participation in a Pacific Basin arrangement that made sense to the Japanese.

In summary, such a nonproliferation strategy does not eliminate the reprocessing option, but (1) delays the decision to reprocess until agreed upon criteria are met, (2) provides a congenial basis for a multinational reprocessing venture (as opposed to a national option), (3) secures an appropriate negotiating atmosphere when/if Japan decides to reprocess, and (4) provides an acceptable basis for agreement for all the concerned parties in the Basin.

The following nonproliferation criteria are therefore suggested for the successful implementation of the Pacific Basin consortium:

- (1) The decoupling of spent fuel storage from other possible nuclear fuel cycle options for the near term.

This decoupling will ensure that a means of storing LWR spent fuel will be found rapidly so as to reduce the pressure to reprocess as a means of spent fuel disposition.

- (2) The U.S. assurance that none of the other possible nuclear fuel options will be foreclosed at any time in the future.

This assurance will allow Japan's participation in the Pacific Basin arrangement while providing for future fuel cycle decisions.

- (3) The U.S. assurance that agreed upon flexibility in spent fuel release will be provided under the arrangement.

This assurance will provide support on the part of the Japanese utilities which are pressured by immediate storage problems, and yet reluctant to give away their spent fuel and attendant residual energy values without guarantees to recover such energy assets.

- (4) The strong U.S. commitment to launch a multinational Pacific operation to handle the back-end of the nuclear fuel cycle.

This support and commitment will enable the U.S. by its very presence, to avoid situations where unwanted technology transfers, development of national fuel cycle alternatives, or possible deemphasis of proliferation concerns could occur. Positive aspects such as reduction in fixed facility safeguards costs could be presented as built-in advantages.

3.3.1.2 The Identification of Business Operations Criteria

On the assumption that each country knows best the way to structure its own participation ownership at the national level, complete freedom on this aspect should be permitted. The Japanese, for instance, have a history of establishing private-public hybrid organizations for major new technical scope activities. National business participants could be in the form of a private firm, or a private-public hybrid entity (i.e., firm or consortium). The membership status within the consortium (i.e., ownership versus customer status) should remain equally open to all nations to secure the largest possible market base for the AFR storage services to be provided by the consortium.

At the multinational level, the arrangement should (1) limit the number of institutional owners (the owners being national or multinational entities) to ensure efficient business operations at the consortium level; (2) secure reasonable flexibility in the retrieval of spent fuel without jeopardizing the financial existence of the AFR facility; (3) provide the appropriate framework for business expansion and diversification to support viable business conditions in the long run; and (4) assure that regulatory uncertainty associated with US siting will be mitigated.

First, along with Japan's desire to be treated as an equal partner in any future spent fuel arrangement, the US and Japan would probably find it appropriate to have an equal share in the multinational venture. As industrial and technological leaders in the Pacific Basin, the two above countries would also probably find it equally desirable to become the principal investors in the arrangement, leaving the smaller countries with a lower level of financial involvement. This implies an important US commitment, which in turn raises questions pertaining to US's ownership structure.

Institutionally, the creation of a US business party to a Pacific Basin spent fuel consortium may be a central problem. Many difficult questions are involved, including:

- o Is there an anti-trust problem with the participation of some (or all) private US concerns in the venture?
- o Will the most technically competent US concerns be affected by possible anti-trust ruling, preventing them from leadership in the US arrangement?
- o What are the practical means for participation in the US arrangement under current anti-trust rulings?
- o Should the federal government participate? If yes, under what basis, and to accomplish what functions?
- o Should the federal government provide loans or loan guarantees, subsidiaries, or other financial incentives independent of (or as a consequence of) its participation or non-participation in the venture?
- o If a lead company is to be designated to ensure good cost control and effectiveness, how is the lead company to be designated?

Second, the marketability of a Pacific Basin AFR facility depends on the provision of flexibility to users to remove the fuel from storage under agreed upon conditions. Such possible retrieval, if premature with respect to facility economic lifetime planning, could represent a significant business instability which should be accommodated by penalty conditions and also preferential treatment for the facility in performance of additional back-end fuel cycle services.

Third, by providing an adequate basis for business expansion and diversification, the multinational arrangement will provide built-in features mitigating the present business uncertainties associated with interim spent fuel storage. Such features could not be substituted for government guarantees (such as loans or loan guarantees) to reduce the economic risk to spent fuel storage, but could, if successful, significantly help in reducing the need for such governmental intervention in the future.

Finally, the nuclear regulatory framework of the Pacific Basin facility would influence the facility development and operation schedules and cost. If the facility were located in the United States, it is assumed that U.S. nuclear regulations and approval processes would apply. If the facility were located on a Western Pacific island, it is possible that the essence of the technical aspects of the U.S. nuclear regulations would apply, but that the licensing process would be simpler and quicker. The nuclear regulatory framework would be fundamental to an agreement for the Pacific Basin facility. Japan and the other Pacific Basin participants would be concerned about possible vagaries of U.S. nuclear regulations should a U.S. site be selected. Indeed, it is possible that such concern would drive the ultimate siting evaluation away from the U.S. Pacific Basin countries probably would seek guarantees if the facility were in the U.S. in areas such as time limits on the licensing approval process and the closure method of the process.

The following business operations criteria are therefore suggested for the successful implementation of a Pacific Basin consortium:

- (1) The launching of a private, multinational spent fuel concern, open to public sector participation at the discretion of national parties.

This business arrangement will satisfy all prospective Pacific partners, while giving each government the option to participate at its perceived most appropriate level, and independently.

- (2) The clear distinction between national and multinational levels for structuring participation and ownership arrangements.

This distinction will allow complete freedom for the parties to structure their own national participation/ownership interface as they deem it desirable, while ensuring (1) free access to purchasing storage services, and (2) US - Japan leadership at the multinational level.

- (3) The clear distinction between business operations functions and regulatory/control functions.

This distinction will ensure operational capability such as permitting the facility to complete its functions in a commercial context and act as a cost minimizer, while giving the nonproliferation and safety controls to the responsible public entities.

- (4) The preference for a multinational AFR concept as an appropriate start up nucleus for further fuel cycle activities.

This preference for an AFR start up will solve Japan's most urgent need for storage space, while (1) ensuring Japan that other activities will be under consideration in the future, and (2) testing the concept with one of the most simple activities in the back-end of the fuel cycle.

- (5) The initiative to find the appropriate institutional arrangement for ensuring stability, guarantees, and reliability.

This initiative will provide the basis for discussions aimed at providing guarantees against reduction or limitation of the economic life of the AFR facility. Multinational cooperation may provide a higher probability of long term reliability than national ventures.

- (6) The U.S. provision of guarantees or other appropriate initiatives for handling nuclear safety regulatory uncertainties associated with a U.S. site.

This applies more to Japan than to the cooperating nations.

3.3.1.3 The Identification of Financial Strategy Criteria

Central to the successful implementation of a multinational spent fuel consortium is the management of risk. Typically, the Pacific Basin arrangement will have to identify a level of financial risk agreeable to all the prospective parties, including private business, governments, the financial community, and utilities. Regulators, investors and customers will likely have specific objectives that may contradict one another:

- o Private business will likely require loan guarantees (or other government - sponsored mechanisms) to reduce their financial risk in the venture

- o Governments will likely focus their attention and support those activities responding to their specific policy objectives
- o The financial community will likely want to maximize their return on investment for an accepted level of risk, thus asking for a required enterprise ROI coupled with government guarantees.
- o Utilities, in turn, will be concerned with bearing high service charges to finance a high required enterprise ROI.

In the Pacific Basin situation, Japan is not likely to deploy its breeder technology before the late nineties. In designing a financial strategy for the Basin, it should therefore be remembered that the financial risk of reprocessing now is higher than in Europe (i.e., present worth or reprocessing investment is discounted at higher rates), and reprocessing equity financing becomes a critical problem to early recovery development. As mentioned above, a high ROI situation would be in conflict with utility interests, and a high ROI venture does not necessarily ensure the participation of the financial community if the risk involved is not agreeable to that community.

In addition, since reprocessing is a capital intensive activity that does not respond to the most immediate need for the utilities (as opposed to spent fuel storage), immediate reprocessing financing involves (1) a high opportunity cost for the utility industry, and (2) a high financial risk for the owners/investors and the financial community. This makes reprocessing a less attractive activity for launching a multinational venture than the less capital intensive interim storage activity

that responds to an immediate need.

The more capital intensive is the project at the startup of the venture, the higher the financial risk, and the higher the required ROI is likely to be for the prospective investor, making the launching of such a venture increasingly more difficult. This indicates that the more capital intensive is the project (like reprocessing), the lower the cost of capital has to be for the project to survive. It implies that the more capital intensive is the project, the more government intervention to reduce risk or capital cost will be needed to make the project acceptable to the other prospective partners (i.e., the utilities and the business and financial community). From a strictly financial risk and business standpoint, the free play of market mechanisms naturally supports the postponement of reprocessing activities in the Pacific Basin until breeder deployment needs occur.

In light of the present Pacific Basin situation, a two-phased financial strategy is suggested for an arrangement in the Basin. This strategy defines near/intermediate term and long term financial criteria.

The following financial strategy for the Pacific Basin consortium offers a possibility of supportive controls on the direction of enterprise activities, such as starting in an interim storage function, remaining in that function for a desired period, and shifting to either a reprocessing (recovery) or a permanent storage function under the appropriate stimulus or conditions.

The strategy includes a possible shifting of financial support between private and public interests in order to influence the enterprise and its participants into desired function directions.

Near/Intermediate Term Criteria for the 1980-2000 Period

The near/intermediate financial strategy criteria centers on the balance to be struck between required ROE conditions for initial equity financing and reasonable service charges to utilities that would ensure maximum customer participation. The following financial strategy criteria for the near/intermediate term are therefore suggested for the successful implementation and development of the consortium:

- (1) The option to use the weighted average cost of debt as an appropriate return on equity.

This option will attempt to recognize that equity capital does have a cost, but at the same time will acknowledge the fact that the equity holders might borrow their equity investment, and thus it will attempt to help them recoup only their cost of funds.

- (2) The decision to allow maximum flexibility between equity financing and loans/bonds availability in shaping governmental participation.

The use of government guaranteed loans or bonds (payable after the AFR facility begins to earn sizeable profits, for instance) would reduce the need for initial owner equity commitment while providing (1) a reasonable cost of services to the utilities, and (2) a good leverage effect for the owner/investor's ROE in the venture.

- (3) Governmental commitments to settle early on durable regulatory requirements for the venture.

To the extent that the regulatory framework (i.e., safety and safeguardability standards) could significantly

impact on the profitability of the enterprise, an early bilateral (i.e., U.S.-Japan) agreement on regulatory standards should be arranged with the assurance that it would represent a reasonably stable framework for the life of the project.

- (4) Governmental commitments to find at an early date, a location for the AFR facility that would be acceptable to all the parties.

To the extent that the location of the AFR facility could significantly impact on the costs of the enterprise (i.e., distance of transportation, additional logistical requirements such as water desalinization, and alternative storage concepts), the early indication of an agreeable site should be assured.

Long Term Criteria for the 2000-2030 Period

The longer term financial criteria allows for a transition phase establishing an adequate financial environment for launching a multinational reprocessing operation in the Pacific Basin. The long term financial strategy criteria centers on the balance to be struck between the cost of (storage and reprocessing) services and the type of products (U_3O_8 vs. MOX fuel) that would be delivered in the Basin. An adequate financial strategy should prevent a basin-wide commitment to reprocessing services for strictly financial reasons, and ensure that financial transactions within the consortium are made on an energy-equivalent basis only for nonproliferation reasons. With such a perspective, the following financial criteria are suggested to ensure nonproliferation effectiveness over the long term period:

- (1) The agreement to allow for possible ROE differentiation between storage only and possible future recovery activities to attract investors (as/if needed) into desired function directions.

5 The allowance for the decoupling of ROE requirements between storage only (with required ROEs close to utility economics) and reprocessing activities (with required ROEs close to private industry levels) will aim at both permitting the launching of multinational recovery services, and maintaining storage only services as a competitive back-end alternative for utilities not vitally interested in reprocessing.

- (2) The agreement to tailor-fit governmental incentives to help consortium management maintain competitive storage only services for both the users and the owners if/when recovery activity is launched.

Such an agreement will ensure governmental support for maintenance of storage only services over the long term period (i.e., interest rates adjustments on public loans made to the consortium could be aimed at balancing the financial attractiveness of reprocessing activities with storage only services for the various parties involved). This is directed primarily at the cooperating nations.

- (3) The arrangement to account for utilities' spent fuel as non-current assets in the newly diversified multinational venture.

This arrangement, coupled with contractual commitments to reprocess could provide a realistic basis for the financial community to invest in the new venture and provide an adequate asset basis for debt financing. In addition, an asset status for utilities, spent fuel will allow cessation of assets among parties. In particular, utilities not vitally interested in reprocessing could exchange such assets for additional storage stock options and get cheaper storage services.

(4) The arrangement to account for spent fuel assets on an energy equivalent basis only.

This arrangement will both serve nonproliferation objectives and allow an agreeable asset valuation mechanism for any of the following customer categories:

(1) storage only service customers that will want a fair evaluation of their optional stocks; (2) LWR recycle customers that will want to recoup the energy value of their spent fuel (irrespective of the reprocessed materials characteristics); and (3) customers with a demonstrated breeder capability that will be primarily interested in Pu feed.

3.3.2 Candidate Models for a Pacific Basin Arrangement

When considering the structure best fitted for a particular multinational arrangement, the following aspects should be carefully kept in mind: the objectives of the arrangement, the nature and scope of activities, the implementation constraints and profitability of the planned activities, and the degree of solidarity among participants, among other factors.

Obviously no standard pattern can be applied which would appropriately cover this variety of factors, and for a Pacific Basin context in particular. Past experience has demonstrated that a "tailor-fitted" approach has been the most successful. The purpose of identifying existing international arrangements is to:

- o provide a starting reference base for further "tailor-fitted" organization development;
- o identify the institutional mechanisms that specifically answer some of the criteria considerations presented in the previous section; and
- o analyze the conditions under which the candidate models have proven to be most successful, or conversely shown to be inefficient.

Four candidate models were examined in the study and three are reported as relevant. The first model is EURATOM, selected because of Japanese interest in exploring the features of this organization for possible concept alternatives. The two other models are the URENCO and the Scandinavian Airlines System (SAS) arrangements, respectively. These two models were selected on the basis of the criteria developed for the Pacific Basin: the URENCO model responding to both the business operations and nonproliferation criteria; the SAS model responding primarily to the business operations criteria.

The principal features of the selected models and their possible major inputs to the development of Pacific Basin arrangements are included as Appendix A.

3.3.3 Preliminary Organizational Options for a Pacific Basin Arrangement

3.3.3.1 Introduction

The analysis of: (1) nonproliferation values and strategies, (2) business management principles, (3) financial strategy criteria, and (4) exemplary organizational models, provides a basis for setting preliminary options regarding roles, missions, functions and responsibilities in establishing a Pacific Basin spent fuel interim storage facility.

The rationale of the formation of the Pacific Basin option is:

- o U.S. and Japan are major partners. Other countries hold minor interests.
- o For U.S., business involvement should include a strong lead private company.
- o The Japanese would be adept at structuring their participation. The ROC, ROK and the Philippines participant structure would be relatively simple. With the U.S. and Japan as the only major parties, obstacles to creating the organization are minimized. The ROC, ROK, Philippines, etc. would join after substantive issues are settled.
- o The business venture would have the maximum flexibility to arrange for and accomplish construction, operations, and ancillary services in an efficient manner. The business venture would respond to proliferation control and safeguards criteria established by the political participants during the formation of the basin arrangement.

3.3.3.2 Scope of Pacific Basin Arrangement

Following the nonproliferation values, implementation strategy, and financial strategy criteria for the Pacific Basin, the scope of the initial arrangement is for interim storage only, with the option open for later discussion of expansion to include permanent storage and/or reprocessing (recovery) and related service functions such as fuel fabrication. The principal rationale is:

- o Availability of interim storage reduces a major pressure by the Japanese for early reprocessing.
- o It is not likely that the Japanese would agree to an arrangement which did not provide them an opportunity to reprocess to support breeder commercialization. There must be conditions allowing the Japanese to withdraw their spent fuel for reprocessing.
- o The other Pacific Basin countries would accept solutions agreeable to Japan, but would be subject to separate treatment on return of spent fuel or reprocessing decisions.
- o Fuel availability guarantees may be invoked on a separate basis for various Western Pacific participants.

3.3.3.3 Identification of Participants

The Japanese business participation is seen in the form of a private firm, a private consortium, or a private-public hybrid. Japanese experience might auger for the private-public hybrid organization. The three largest Japanese nuclear utilities may well share the leadership.

The ROC business participation would be by Taiwan Power Company.

The ROK business participation would be by Korea Electric Company.

The U.S. business participation is still undefined. Optimally, a single U.S. company would maintain control through 51% ownership. The partnership would be arranged through the lead company's discretion.

The proliferation control participation would be set by the appropriate government organizations in each country.

The Philippines probably would follow the ROC/ROK in formulation of participants.

Canada, if involved, probably would follow the U.S. lead in formulation of participants.

3.3.3.4 Identification of Proliferation Controls Functions

The participants identified for proliferation control would perform the following functions:

- o Release criteria and mechanism

The participants would establish in advance the rules, procedures and decision-making criteria for the release of spent fuel and nuclear material, including the mechanism under which release is accommodated, (such as "at the request of the member"), and also the conditions for release, for example, "return to user."

- o Safeguards criteria and requirements

The participants would establish nuclear safeguards requirements for system design and operation, including fixed facilities and transportation. Included is the criteria for the safeguards and physical security force, including its composition and reporting responsibilities (probably reporting to the proliferation control participants). The relationship between the safeguards and physical

security organization and the business/process operations organization would be established by agreement between proliferation control and business participants.

o Host country relationships

Agreements with the host country would include:

- National right or limitations on rights to interfere with ingress and egress of nuclear material.
- The venture's right, if any, to apply physical security measures, and the relationship of its physical security and safeguards responsibilities to those of the host country.
- The rights or limitation on rights to termination of the agreement, and the disposition of material in the event of termination.
- The sanctions for violations by either party.

3.3.3.5 Identification of Business Operations Functions

The business participants would perform the following functions:

o Proliferation control/business operations interface

Develop an agreement with the proliferation control participants with respect to the interface between proliferation and business functions. The proliferation control interests would dominate in the negotiation; however, if the business venture interest is driven to a non-interest position, then the project has failed at the start.

o Capitalization/financing

Each country's participation would be raised as they choose (private, public, mixed private-public).

Government subsidies are acceptable, particularly if they are not hidden.

- o Development/operation management

The business entity contracts for or develops internally:

- o facility and equipment design and fabrication
- o site preparation
- o construction
- o operations

Note: These functions should be performed under the single management of the business venture, being able to draw on the most efficient sources of supply; however, the overall venture negotiation may dictate various specified national sources to accommodate balance-of-trade and other national level issues.

- o User (customer) base

Assuming first allocation of service to investor participants, the service should be available to any entity which desires the service - governments, utilities, private firms - so long as business, nonproliferation and environmental interests are preserved. Presumably most of the facility output would be allocated at the outset.

No purpose seems to be served by restriction of the customer base; such restriction might limit an opportunity for the venture.

In practice it is likely that the venture would obtain commitments to store spent fuel before it commits to facility investment. In Japan and other Pacific nations, it is likely that the owner-participant and customer will be the same institution

or otherwise have an aligned interest. In the U.S., the customer may be the government or utilities or both. It is therefore likely that most facility capacity will be naturally allocated at the outset.

o Relationship with host nation

In concert with the proliferation control participants, the business participants would determine the relationship between the facility and its associated shipment activities and the host nation. Included in this are the land use conditions.

o Service terms and conditions

They are widely open to discussion:

- In order to meet financing requirements, the contracting could provide for completion and operation of project commitments.
- In order to support credit worthiness requirements, the contracting arrangement could be based on governmental guarantees. Institutionally, a less demanding approach could be to propose "deliver-or-pay" contracting commitments for the Pacific Basin spent fuel venture (including any U.S. spent fuel participation). This could also be coupled with an "operate-or-pay" commitment associated with the service activities.
- Fees for investors would be cost based, subject to independent audit. The fee structure may or may not favor disproportionately large investors (with respect to usage requirements).
- Allocation of capacity reserved first for investors; then on a first-come-first-serve basis. Letters of intent probably would be required to secure initial capitalization

- If uncertainty of user requirements develops, a possibility is to sell options for storage, at a reduced fee, for a restricted portion of the facility capacity. The options could be fungible with right of first refusal to the venture.

- o Regulatory function

The proliferation control and business participants, in consultation with the host country, must agree on proliferation controls and safeguards licensing and inspection/enforcement activities, including the IAEA safeguards activities.

The business participants and the host nation must agree on health and environmental safety licensing and inspection/enforcement activities.

The business participants must establish or select an independent auditing capability which certifies the cost accounting and spent fuel and nuclear material accounting.

3.3.3.6 Identification of Key Organizational Features and Options

Key organizational features for the development of a Pacific Basin concept cover the five following areas: general principles for organization, possible organizational structure and options, possible financial structure and organization options, possible regulatory and control organization options and possible arbitration mechanisms. These subjects follow in order:

- (1) General principles for organization include:
 - o A URENCO-type distribution of functions among distinct organizational components, separating business operations functions from nonproliferation, safety, and other regulatory functions.

- o An SAS/URENCO-type distinction between national and multi-national levels to structure ownership participation (i.e., ensuring maximum flexibility at the national level, but restricting the number of participants at the multi-national level).
- (2) Possible organizational structure and options include:
- o An SAS/URENCO-type advisory committee to develop and implement appropriate regulatory framework and ensure observance of regulatory dispositions. With respect to nonproliferation issues, the committee's output would be mandated upon the business operations. The advisory committee would also provide timely advice to the Board relative to business policy (only at the Board's own request), and resolve political issues that may conflict with growth of Pacific Basin concept.
 - o An SAS/URENCO-type executive Board solely responsible for all business operations questions before the shareholders (i.e., the institutional entity representing their interests). According to its own needs, the Board of Directors could ask for the advice of the advisory committee on business policy matters.
 - o An SAS-type autonomous audit entity reporting administratively to the shareholders and to the advisory committee to independently conduct cost, spent fuel and nuclear material auditing.
 - o A EURATOM (ESA)-type business operations framework for the AFR facility to secure its right of option for all the spent fuel generated in the Basin and its exclusive right to conclude contracts.

(3) Possible financial structure and organization options include:

- o An SAS/URENCO-type corporate equity financing with a small number of participants (a participant representing one or several countries) to ensure business operations effectiveness at the multi-national level. A balanced distribution of the shares would occur between the major participants.
- o An SAS/URENCO-type flexibility for private, public and hybrid (i.e., private-public) financing at both national and multi-national levels to allow for any possible ownership configuration.
- o An SAS-type financial organization providing a distinction between ownership of assets and ownership rights to leave spent fuel titles in the hands of national parties.
- o An SAS/EURATOM-type accounting format whereby the national parties are the spent fuel owners (SAS format), the consortium (or holding company) represents the shareholders' interests and has the property rights over the spent fuel (SAS format), and a wholly-owned enterprise (the AFR facility) to be the managing spent fuel agent for the consortium and which will therefore be treated as a user from an accounting standpoint (EURATOM format).

3.3.4 Proposed Organizational Architecture

On the basis of the preliminary organizational options described in the previous section, the following organizational architecture is proposed for the Pacific Basin consortium

As a result of the first general principle allowing for a distinction between nonproliferation/regulatory and business operations functions, Figure 3-3 presents the principal elements of the corporate structure of the consortium according to well delineated responsibilities and functions. As shown in Figure 3-3 a government-to-government treaty would provide the basis and framework for launching and operating the consortium. Following the SAS and URENCO examples for setting the participation structure at the multinational corporate level, the Treaty would create a General Council (GC), an Audit and Control Bureau (ACB), a Board of Directors (BOD) and a Meeting of shareholders.

The Meeting of shareholders would be responsible for capital formation to meet the initial and on-going capital requirements as established by the Board of Directors. The Meeting of shareholders would elect the Board of Directors (BOD) and approve the annual report of activities.

Following SAS' participation rule, the voting power of the shareholders in the Meeting would be proportional to equity financing. For the Pacific Basin consortium, this principle implies an equal decision-making power between the sponsoring nations (based on their respectively equal equity financing participation), and a weighted decision-making power between sponsoring and cooperating nations, and among the cooperating nations themselves.

The General Council (GC) would be an independent regulatory head, representing the participating governments, with principal responsibilities in nonproliferation and safe-

Corporate Organization of the Pacific Basin Consortium (PBC)

UNDERLYING PRINCIPLE: DISTINCTION BETWEEN NONPROLIFERATION/REGULATORY AND BUSINESS OPERATIONS FUNCTIONS

Figure 3-3
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guards policy and regulatory matters. The GC would provide direction in these areas to the Board of Directors. Following the organizational function of URENCO's Joint Committee, one of GC's roles would be to provide timely guidance to the otherwise autonomous venture management on commercial, production and other business policy matters that could give rise to problems of a political nature.

The Audit and Control Bureau (ACB) would be responsible for physical protection and material accountability and control within the facility environs, and over material in transit. The ACB would also be responsible for both independent cost and nuclear materials auditing.^{1/} It would report administratively to the GC. All information coming from the ACB, however, should be made available to both the GC and the BOD including its PBC management staff.

The Board of Directors (BOD) would be in charge of all the business operations of the consortium. In particular, the BOD would be in charge of defining corporate business policies, implementing environmental, health and safety standards, managing the internal operations of the group, and contracting work with external firms to the consortium. The BOD would be regulated by the GC for nonproliferation and safeguards matters.

The regulatory requirements of the host country would be coordinated by the GC and BOD as appropriate. The environmental, health and safety requirements of the host country would fall principally upon the BOD and the business operation.

At this point, the study assumptions regarding development of functional capabilities may be outlined. Three functional capabilities are envisaged for the PBC:

^{1/} Combination of cost and nuclear materials auditing activities is subject to further discussion.

- (1) facilities to conduct spent fuel storage and other fuel cycle activities as authorized, excluding permanent disposal,
- (2) facilities for permanent disposal of spent fuel or HLW, and
- (3) transportation capabilities.

The study assumptions are:

- (1) The facilities for spent fuel storage and other fuel cycle activities, excluding permanent disposal, are the responsibilities of the PBC enterprise. It is more likely that the enterprise would develop these facilities as an internal operation rather than obtain contracted facilities services from an outside organization.
- (2) The facilities for permanent disposal of spent fuel or HLW are the responsibility of the governments involved in the PBC and not of the PBC enterprise.
- (3) Spent fuel (and HLW) transportation services could be provided by transportation carriers under contract or by an internal organization of the PBC enterprise. Shipping casks could be provided by either the enterprise, the reactor operators, or a contract carrier.

As a result of the second general principle allowing for a distinction between national and multinational levels, Figure 3-4 identifies three(i.e., subnational, national and multinational) levels of organization in the Pacific Basin consortium enterprise. At the subnational level, maximum flexibility would be allowed for private, public and private-public hybrid participation and concept formation as/if required.

At the national level, maximum flexibility would still be allowed for private, public and private-public hybrid concepts that constitute the national shareholders of the multinational consortium enterprise. One of the key functions of the national shareholders would be to reduce the number of participants into few major partners for consortium enterprise management. For the smaller cooperating nations (i.e., ROC, ROK, and the Philippines) an optional joint entity could be launched (at their request) to enhance their decision-making position at the corporate level of the consortium enterprise. Such a joint entity would then be in the same approximate position as one of the national shareholders of the sponsoring nations.

At the multinational level, participation would be fashioned after agreed upon guidelines and principles. One of such principles could specify that U.S.'s share in the consortium should equal the Japanese one, and that the sum of the shares of the smaller cooperating nations should not exceed that of the U.S. or Japan. Another principle could state that to have a sponsoring nation role, a minimum level of 30 percent equity financing will have to be reached by the (national or multinational) shareholder.

As a basis for discussion, the SAS Agreement can provide many interesting financial features that are worth exploring for the development of the PBC enterprise. The SAS type arrangement could provide a financial framework that would permit an advantageous treatment of spent fuel over time. On the one hand, the title to spent fuel would remain in the hands of the national owners; on the other hand, the PBC enterprise would have the beneficial rights to the spent fuel.

Organizational Architecture for a Pacific Basin Consortium Enterprise

UNDERLYING PRINCIPLE: DISTINCTION BETWEEN NATIONAL AND MULTINATIONAL LEVELS FOR CONCEPT FORMATION

The capability of reporting the accumulated spent fuel overflow of the entire Pacific Basin as assets in the enterprise's consolidated balancesheet, without renouncing national ownership and title to the spent fuel, would endow the PBC enterprise with considerable financial leverage for funding possible energy recovery options in the late nineties, should this become economically attractive and politically acceptable. Such a prospect would create a driving force cementing the national partners together to operate through the PBC enterprise for developing balance of fuel cycle activities. However, such a financial leverage could only be obtained if an agreement were reached to account for the spent fuel as an asset at the PBC enterprise level, since the SAS agreement only provides an efficient financial framework for such an accounting procedure.

Before highlighting some of the financial features of the SAS Agreement, it should be recalled that decisions for the consortium to engage in further fuel cycle activities such as reprocessing would be the responsibility of the General Council, under the postulated Treaty.

The day-to-day financial management linking national and multinational levels in the PBC enterprise could be patterned after SAS' functional organization. Functionally, the three national holding companies of the SAS consortium (Denmark, Norway and Sweden) can be thought of as specialized banks; the latter being specialized in two ways: (1) they have basically (but not exclusively) one client (SAS) which in turn is their (quasi) exclusive enterprise; and (2) their financial support focuses on the development of the air transport and travel industry for Scandinavia. The basis for the enterprise is an agreement (the SAS Agreement) that pools the resources of the parties together to achieve specific goals, under well delineated, and accepted principles. Some of the key principles include:

- o ownership of assets is in the bankers' hands
- o management of assets is in the enterprise's hands
- o enterprise has no legal country or legal structure

This setting has many interesting features for a PBC concept where banks in the respective participating nations would provide the equity financing of the PBC enterprise. Similarly, such banks could be specialized in having one major client, the PBC enterprise, and in primarily supporting the development of a global spent fuel logistic system for the Pacific Basin.

From an equity and debt financing standpoint, such an organization would spread the risk of fund raising over an efficient network of national banks, and therefore best utilize their knowledge about their respective financial markets. To weigh the advantages of an SAS-type PBC enterprise over possible organizational alternatives, one would have to envision a situation where, everything else being equal, the multinational enterprise would have to raise money independently, without the credibility of a permanent banking network, formally recognized as the shareholders of the enterprise. In addition, SAS' two-tiered (national banks-multinational enterprise) structure has proved to be a very efficient stabilizing mechanism. In many occasions, the national banks operated as buffer agents where conflicting national interests were sorted out, and made compatible with the objectives of the SAS enterprise.

From a legal standpoint, SAS' financial organization solves the problem of ownership transfers of national assets while permitting the formation of a multinational enterprise. In the SAS model for instance, aircraft continue to be the property of the national shareholders, and since SAS has no legal structure or legal domicile, the planes cannot be registered in the name of the consortium. In order to forestall any future disagreements on this point, the SAS Agreement states that "all the aircraft shall internally be considered as the property of the consortium." It also specifies that the consortium "shall

have the authority to control, use, charter and rent the planes as well as to dispose of them through sales."

With the necessary and appropriate adjustments aimed at fitting the spent fuel business environment, a PBC Agreement could lay out similar financial/legal principles and modes of operation. In an SAS-type PBC enterprise, all the assets (such as spent fuel, equipment, and other investments) would have a similar standard financial treatment. Obviously, SAS' financial/legal regime is only one of many possible alternatives, and the proposed organizational architecture does not preclude any alternative. One alternative, for instance, could be to treat spent fuel as a special asset (to be managed according to SAS' financial/legal regime or otherwise), while the ownership of the other assets would be in the hands of the PBC enterprise.

The SAS regime has, however, the merit of being a simple, comprehensive, and flexible approach to multinational financing that has proved to be very efficient over time. This approach could greatly simplify the problem of equity financing in spent fuel concept formation, and avoid the issues of ownership transfers of national assets.

More importantly, the application of an SAS-type regime to a PBC enterprise would present the advantage of treating spent fuel assets as common assets (since title of spent fuel would remain in the hands of the national partners as for any other assets), and would allow a simple and flexible financial/legal regime to rule the entire management of the PBC enterprise.

Supposing that the general rule was to endow the PBC enterprise with the title of ownership of its assets, a special regime would have to be found for the spent fuel if the latter were to be treated as assets in the balance sheet of the

PBC enterprise. Although feasible, this option would have two major drawbacks. First, it would substantially complicate the accounting and financial management of the PBC enterprise by instituting two parallel systems. Second, it would not provide the same financial leverage benefits as one could expect otherwise. For debt financing, the PBC enterprise will have a stronger financial leverage if it can pledge all its assets on a common basis without having to qualify or condition its pledge for some parts of its assets. The financial community would see an additional risk in a dual regime for the assets, particularly if the duality of the regime were introduced (or applied for the first time) for major debt financing projects that may be launched in the future. This would, to some extent, undercut the dynamics of the leverage effect.

While being perfectly consistent with nonproliferation objectives, the treatment of spent fuel as a normal asset could have a decisive financial advantage for the development of an SAS-type PBC enterprise. In the near and intermediate term, spent fuel assets will be of low value (i.e., small amounts over the entire Pacific Basin, and no available feed to support a cost effective recovery operation). Yet, by year 2000, the situation will have changed (i.e., an AFR operation will have concentrated enough spent fuel to feed a cost effective recovery operation), and spent fuel assets could then represent a high financial value. Such an incremental increase of assets over such a period of time could, with contractual commitments to reprocess, provide the necessary leverage for the debt financing of a late 1990 recovery activity with less dependence upon major governmental participation.

The accounting procedures of SAS' financial organization are quite simple if one keeps in mind the bank-enterprise analogy. To track SAS' accounting flow, let us take the example of an aircraft being bought by Sweden for SAS' use. The Swedish banker will carry its shareholders' investment (i.e., the aircraft) as a liability in his balancesheet, and will correspondingly increase his share in SAS (the banker's assets). The multinational enterprise (SAS) will carry its property and equipment (i.e., the aircraft) as an asset, and the banker's participation in the enterprise as a liability. The double counting of assets is therefore eliminated: aircraft are accounted as such in the enterprise's balancesheet only. A similar accounting framework could be envisioned for the PBC enterprise.

With such a mode of equity financing and accounting procedure, attention should be given to the long-range utilization levels in the AFR facility to strike a balance in the decision-making power of the two sponsoring nations. To the extent that the foregoing financial/accounting approach is aimed at providing adequate financial leverage, but not at changing the character of the multinational partnership, stabilizing accounting mechanisms would also be desirable. Several such mechanisms are conceivable. For instance, the shares of the respective partners in the PBC enterprise could be represented by two classes of equity: common stocks (with voting rights), and preferred stocks (having no voting rights), both of which would otherwise be equal in all respects. Spent fuel could be incorporated as common stocks to the extent that such equity increases would not change the initial, and agreed upon proportion between the common stocks of the sponsoring nations over time. Spent fuel unaccounted for in common stock adjustments would then be reported as preferred stocks in the consolidated balancesheet of the PBC enterprise.

Since SAS has no legal personality, tax problems, depreciation issues, and siting pressures for SAS operations are greatly reduced. SAS is not taxed on its profits. However, the national bankers are taxed on their SAS profits. Taxation is therefore left at the discretion of the national authorities. The assembly of shareholders (a 50 percent private-public hybrid) has the authority to decide what part of the non-taxable profits should remain in SAS to increase the capital of the consortium if/as deemed desirable. Depreciation rates are determined by SAS' Board of Directors and submitted to the Assembly of Shareholders for approval. Finally, the siting of the SAS operations is left to SAS management as they see it most cost effective from a business standpoint. In the PBC context, however, the General Council could provide inputs to the siting process to the extent that nonproliferation considerations would be involved.

3.3.5 Formulation of a Material Accountability and Control Regime

The formulation of a control regime for multinational fuel cycle activities requires definition of the roles to be played by each of the elements of the consortium as well as by the host country and the international community in the end-use verification and physical protection of nuclear material entrusted to the consortium. More specifically, the control regime encompasses the measures employed by:

- the plant management
- the stockholders
- the member states of the consortium
- the host country, and
- the international community, as represented by the IAEA

in

- verifying the location and proper use of nuclear material
- providing physical protection of facilities and materials in the possession of the consortium

- deciding upon the acceptance and release of materials, and
- material en route to or from consortium facilities.

There is universal recognition of the primacy of the IAEA in the application of safeguards. The Agency would accordingly be responsible for verifying compliance by the consortium itself, through a multinationally staffed Audit and Control Bureau directly responsible to the General Council of Consortium Member States, would establish and operate a materials accountability and control system which provided necessary data to the IAEA, at the same time satisfying consortium members that material in their custody was not diverted to unauthorized use.

Physical protection at and beyond the site perimeter would be provided by the host country, which would thus assume primary responsibility for protection against subnational threats. However, physical protection within the site perimeter would be the responsibility of the Audit and Control Bureau, which would thus provide barrier to national seizure or violation. While it is manifestly impossible to endorse the multinational control staff with sufficient police power to resist a successful national takeover, considerable importance is attached to the principle that national violations should not be possible without the application of some force, however slight.

The critical responsibility of deciding upon release of materials deposited with the consortium, or products derived from these materials, would be assigned to the General Council of the Consortium, which would exercise the authority in accordance with procedures and substantive guidelines established at the outset. Factors such as the development of an international consensus on the nuclear fuel cycle and the need of the depositor for the return would be adopted for future decision on extending the operation of the consortium to recovery of the energy value of spent fuel.

While the proliferation and security hazards attendant upon the international transport of spent fuel are relatively slight, the responsibility of the consortium for protection of material should be extended to spent fuel in transit, in part to take advantage of this opportunity for establishing a useful precedent for the international protection of spent fuel.

A more detailed account of materials accountability and control considerations is presented in Appendix B (Materials Accountability and Control Regime Considerations).

3.4 SITING CONSIDERATIONS

3.4.1 Introduction

Possible site alternatives for a Pacific Basin spent fuel AFR facility include North America and the Western Pacific Islands. Japan has been screened out as a possibility at this stage of concept development because of Japanese views regarding the difficulty of storing foreign fuel. The siting objective includes the support of recovery and permanent disposal functions, as well as interim storage, although it is recognized that permanent disposal siting maybe difficult. It is presumed that the project could be viable without permanent disposal co-located.

Western Pacific Islands

Preliminary research efforts indicate that very little site-specific information exists about the suitability of Western Pacific Islands for locating a nuclear fuel facility. The study team is currently involved in assessing plant site alternatives with the assistance of the following U.S. Government organizations:

- o Department of Energy
- o Department of State, Scientific Affairs-International
- o Environmental Protection Agency, Office of International Activities
- o Department of Interior, Office of International Geology, and Office of Earthquake Studies
- o Nuclear Regulatory Commission, Fuel Cycle Division

As a result of meeting and interviews with U.S.-government experts in the various fields, the following list of generic criteria was developed:

- o Ecosystem Uniqueness: includes unique land forms and landscape, tropical forests; unique species (terrestrial and aquatic); endangered species.

- Bedrock Geology: geologic origin (e.g., volcanic versus coral origin); bedrock porosity; potential for building material.
- Seismicity: location of sites with respect to edges of tectonic plates; historical record of seismic movements; likelihood of future seismic activity.
- Meteorology: weather hazards; typhoon origin and track, frequency and intensity.
- Surface Water Supply: potential for site to support facility primarily with surface fresh water supplies; conditions of subsurface hydrography for water makeup considerations in dry season.
- Access and Safety for Transport: depth profile; protective reef configurations; existing man-made features including deep water ports; areas with known navigational difficulties increasing transport risks.
- Primitive Cultures: anthropological uniqueness of population on site; knowledge of population on site about western technology and culture.
- Governmental Arrangement: Government or country in charge of site/island.
- Demography/Development: current population density and trends; sources of economic development; possible conflicting economic interests.
- Legal/Regulatory Situation: potential conflicts between existing legal/regulatory framework and the siting/operation of a nuclear facility.
- Political Acceptance: likely acceptance of local population as well as international community for locating facility on a particular site.
- External Influences: proximity of high density traffic areas and international maritime routes.

- o Project Infrastructure: labor base, housing, transportation, construction materials, industry.

Finally, specific siting criteria have been outlined to take into account technical/cost constraints of AFR facility siting, maritime transport, and geographical constraints for two types of interim storage concepts: (1) a land-based AFR concept, and (2) a barge-mounted AFR concept. Thus the following criteria:

- o Identify a site capable of supporting interim storage (cumulative storage capacity of approximately 22,000 MTU by 2000) and of providing a potential base for future fuel cycle activities.
- o Identify a site capable of providing an extensive, well sheltered area (for a cumulative storage capacity of approximately 22,000 MTU by 2000) and capable of accommodating barges of 1 million tons and of 30 to 40 meters draft (the barge-mounted concept). This site should also be capable of providing a potential base for future fuel cycle activities.
- o Give attention to transportation costs in regard to facility location (for either concept).
- o Eliminate:
 - Any site with coral origin or any site not having an adequate area above an elevation of 500 feet.
 - Any site close to the edge of the Western Pacific tectonic plate (for either concept).
 - Any site on typhoon tracks (historical records). (for either concept). Avoidance of typhoon tracks, however, does not eliminate weather hazards.

With the above generic and site specific criteria, preliminary site screenings could proceed, and Western Pacific Island site

alternatives could be identified in the near future to allow timely decisions for the development of the Pacific Basin consortium.

Potential U.S. Sites

The study effort is examining accumulated research to date relative to potential U.S. sites for nuclear fuel storage and other fuel cycle activities. State government officials have been contacted concerning technical, political and policy matters related to serving as a site for a Pacific Basin spent fuel storage facility and also for other fuel cycle functions. This examination is very preliminary and would not proceed further without direction from the U.S. government.

3.5 LEGAL AND REGULATORY ISSUES

3.5.1 Introduction

Conception and planning of a Pacific Basin spent fuel storage facility will involve many complicated legal and regulatory issues. Some of these issues arise from the effect that present laws, regulations and treaties would have on facility construction and operation. Other such issues involve new legal obligations, such as treaties or other agreements, and possibly new legislation or regulations, necessary before the project could proceed.

Institutional factors discussed elsewhere in this presentation are closely related to legal and regulatory issues. Institutions are created by law, and operate under law, for example through regulations, resolutions, by-laws and authority to contract. Because of this close relationship, discussion of legal issues and institutional arrangements may overlap at this preliminary stage of conception of a Pacific Basin facility.

3.5.2 Present Legal and Regulatory Framework in Pacific Basin Countries

The present legal and regulatory framework varies from country to country, and most nations have one or more legal or regulatory difficulties that must be resolved. While a more detailed discussion for each nation appears

elsewhere^a, the principal critical issues include the following:

3.5.2.1 Maintaining Spent Nuclear Fuel at the Reactor Site

In the Pacific Basin nations studied (Japan, Korea, and the Republic of China), a license amendment is required for enlargement of the spent fuel pool for additional at-reactor spent fuel storage capacity. There are no regulations governing minimum holding period for at-reactor storage, nor for storage capacity, although informal guidelines have been established by the competent authorities in each nation.

3.5.2.2 Interim Spent Fuel Storage Away from the Reactor

In the Pacific Basin nations there are general regulations on use of spent fuel which require that a storage facility be licensed by the competent authority. Such a facility, which would principally be used for possession of spent nuclear fuel only, would normally be expected to undergo a less extensive regulatory process than other fuel cycle activities.

3.5.2.3 Relationship of Spent Fuel Handling to Reactor Program

In Japan, it is necessary to include plans for spent fuel handling in an application to build a new reactor. The other Pacific nations have no such requirement.

*GSFLS Interim Report - Volumes 2 and 2A

3.5.2.4 Transportation

In the Pacific Basin countries, transportation is regulated by one or more governmental authorities, depending on the mode of transport. This is a requirement, however, that does not appear to be an undue hindrance, given the widespread adherence to IAEA guidelines. While the regulations are generally complex, it is expected that whatever transportation licenses are required would be routinely obtained.

3.5.2.5 Import and Export Issues

The Pacific Basin nations require licenses prior to allowing import or export of spent fuel. Agreements with fuel supplier nations restricting retransfer may also restrict spent fuel exports. The legal procedures are relatively well-defined and have posed no impediment to international nuclear commerce in the past.

3.5.2.6 Safety, Safeguards and Environmental Requirements

In every nation the competent authorities have promulgated regulatory standards to govern radiological safety. While these provisions are often strict and/or costly, broad national adherence to the recommendations of international bodies such as the International Commission on Radiological Protection and the International Atomic Energy Agency ensure that the differences in legal regimes pertaining to radiological health and safety do not pose an undue obstacle to the development of interim spent fuel storage facilities.

As to safeguards, the Pacific Basin nations reviewed in this study have signed the Nonproliferation Treaty (NPT). While most national authorities have also adopted the IAEA recommendations contained in INFCIRC 225/Revision 1, differences in physical security requirements do exist and the current worldwide uneasiness over the efficacy of existing safeguards and physical security could exacerbate the situation.

Environmental law varies among Pacific Basin nations. While Korea has a national law, Japan depends on local law and the Republic of China has no special requirement.

3.5.2.7 Third-Party Liability

Each nation has comprehensive regulations, including financial security and indemnity provisions. However, other provisions, such as those governing liability limits and territorial scope, differ considerably, and these conflicts would need to be resolved before establishment of a centralized facility.

3.5.2.8 Public Participation

The Pacific Basin nations studied generally have few legal provisions governing public participation in the licensing process. Public opposition to a spent fuel facility could occur and is an important factor in siting decisions.

3.5.3 New Legal Obligations Associated with the Facility

In addition to consideration of the present legal and regulatory framework, nations considering participation in an international spent fuel storage facility will wish to settle among themselves a multitude of legal issues. Their discussions will probably culminate in a comprehensive written agreement. Some of the legal issues that need to be addressed in such an agreement are the following:

3.5.3.1 Participating Parties

The participants will need to draft provisions governing the number of parties to allow, as well as their nature and function. Some participants may be governments or their agencies, some may be private corporations, and government private hybrids may also participate. Governmental involvement at some level seems probable due to the political sensitivity of spent fuel storage, but not all participants may be governments. While the host and some other participants may be governments, non-governmental participants may include fuel owners and fuel suppliers, as well as those who construct or manage the operation.

3.5.3.2 Form of Agreement

Related to the nature and functions of the participants is the form of their comprehensive agreement. A convention leading to a treaty is the most probable form, but an exchange of notes or a commercial contract may be used as a substitute for or as an adjunct to a treaty.

3.5.3.3 Form of Operating Entity and its Management

The type of entity the participants choose to operate and manage the project will have a strong effect on participants' legal involvement in the facility. Its form may be influenced by legal requirements of each participant, by the lender if he is not a participant, and by any other existing institutions which may be involved, e.g. IAEA. Definition is required of the authority of the operating entity, e.g. to make policy, retain and dismiss personnel, and supervise handling and storage. Of interest may be a two-tier structure, consisting of an upper-tier intergovernmental body responsible for policy, and a lower-tier operating organization.

3.5.3.4 General Rights and Duties of Participants

In addition to defining the rights of a participant in management, his other rights and duties need to be provided in the agreement. His rights might include the right to use the facility, the right of ownership of spent fuel stored at the facility and the right to retrieve it, the right to receive new technology used in construction and operation, and the right to contract to supply related goods and services procured. Conversely, the participants may have to agree to corresponding duties, such as the duty to participate for a minimum period, the duty to store his nation's spent fuel there, the duty to finance the project, as well as the duty to protect any new technology received.

3.5.3.5 Regulatory Requirements and Licensing

While each nation has an existing regulatory framework (See Section 3.5.2 earlier), the participants will need to determine what regulations will govern the facility. It could be the regulatory scheme of the host country, or it could be a new system devised by the participants. In some regulatory areas national laws are relatively uniform, e.g. transportation, safeguards and third-party liability, so the choice should not be difficult. Other regulatory areas, such as licensing of facility design, may be more difficult to resolve.

3.5.3.6 Nonproliferation

Nonproliferation may be a goal of the project, and meeting this goal will require carefully drafted legal obligations. Present law, such as the Nonproliferation Treaty and IAEA regulations, may help shape the participants' provisions on both nonproliferation and physical security.

3.5.3.7 Financial Commitments

The participants will need to provide for financing of construction and operation of the facility. Financial risks of the venture may be high due to political sensitivities, so obligation of governments, perhaps by loan guarantees, may be necessary.

3.5.3.8 Conflict of Laws and Dispute Resolution

The participants in any international venture are likely to find that their agreement conflicts with some aspect of national law of at least one participant, particularly the host nation. Therefore, new legislation may be necessary to settle the conflict. After the legal regime is modified to avoid conflict of laws, disputes may still arise among participants. Their agreement should provide a mechanism for prompt resolution of such a dispute, perhaps by arbitration.

3.6 FINANCIAL CONCEPT

3.6.1 Financial Characteristics

The recommended concept for a Pacific Basin Spent Fuel Logistics System (PBSFLS) as operated by a Pacific Basin Consortium (PBC) has the following financial characteristics:

- a. Function: The PBC is considered to be a complete operating entity formed for the purpose of disposing of spent fuel from nuclear power plants. The PBC entity receives the fuel at a shipping dock at the reactor and is the only entity with which the utility companies must deal to dispose of their spent fuel. However, for purposes of analysis the PBC has been considered as made up of four financial entities. These cover the functions of transportation, interim storage, recovery, and permanent storage.
- b. Fuel Populations: The PBSFLS is designed for and is considered to dispose of fuel from the Pacific Basin countries from 1985 through 2030. The population includes current reactors and projected new reactors to be in operation by the year 2000. The year by year spent fuel shipment to the PBSFLS has cumulative values of:

<u>year</u>	<u>cumulative shipment - MTHM</u>
1990	3800
2000	21800
2030	114800

The cost analysis makes provision for the complete purchase and depreciation of facilities and equipment by completion of the study period (2030) with all capital costs chargeable to the 114800 MTHM.

- c. Location: The recommended PBSFLS is considered to be located on some island in the Pacific. Average one-way shipping distances to this island are slightly over 4000 miles. The island is not considered suitable for geologic storage, thus necessitating the use of air cooled vaults. The island is considered to be isolated and not have a sufficient infrastructure to support construction or operation of the facility at normal costs. Provisions are allowed for creation of the needed infrastructure. These provisions are considered to increase construction costs and island operation and maintenance costs by a factor of 1.5.
- d. Financing: The recommended PBSFLS is considered to be a private company with private financing which owns all of the PBSFLS except the permanent waste disposal facility. The permanent waste disposal facility is considered an activity of participating governments who have entrusted operation to the PBC. PBC ownership is maintained by investors who organize and manage the company and provide some capital as equity. Additional capital is borrowed from the financial community. It is considered that the financial communities assessment of the risks associated with PBC will be such that favorable borrowing can not be provided without suitable guarantees being provided by the government(s) of Japan and/or the U.S. With suitable guarantees very favorable credit provisions may be obtained. The PBC is considered to have government guarantees and to have the following credit capability.
1. The PBC provides a minimum of 10% of any capital payment. The remaining 90% or less of capital payments are borrowed.

2. During the initial construction period when capital costs are being incurred but no income is available, the PBC will pay no interest or payments toward principal. Interest will be accrued however and capitalized as part of the PBC investment during the first year of operation.
 3. Loans are paid back in a manner similar to that of mortgages at 10% interest.
- e. Pricing: The PBC adjusts its service charge to the utilities for spent fuel received to obtain the established rate of return on investment. This return is based on the total project capitalized investments without financing and before taxes. Pricing is done separately for each PBSFLS function as follows:
1. Transportation - A fixed fee is charged for each KgU of spent fuel brought to the PBSFLS. The fee is adjusted to bring a return on investment of 12½% over the period from 1980 to 2030.
 2. Temporary Storage - A fixed storage fee is charged for each KgU of spent fuel brought to the PBSFLS before 2000. This fuel is placed in temporary storage. Fuel received after 2000 is handled in the temporary storage facility and a small handling fee (\$15 KgU) is charged. Spent fuel received before 2000 will be withdrawn from the temporary storage between 2000 and 2030 when no income is being received for this fuel. Costs will be incurred during this period. These costs are in the fixed fee received prior 2000 as a pre-payment. The storage fee is adjusted to provide a 12½% return on investment.

3. Recovery - A rebate is provided by the PBC to the utility for each KgU of spent fuel completing the recovery process. This rebate is a portion of funds received from sale of the recovered products. The value of recovered products is considered to be about 260 \$/KgU in 1990 with a real price increase due to increasing scarcity of fuel of about 1.2% per year. This results in a average value of 349 \$/KgU over the recovery period from 2000 to 2030. The rebate is adjusted such that a 17½% return on investment is provided in the period through 2030.
4. Permanent Storage - Permanent storage is considered to be a government activity. A fixed fee is charged on each KgU received by the facility. This fee is adjusted to allow the owner governments to recover, their costs. The fee is determined on the basis of 100% borrowing at 7% which is equivalent to an ROI of 7%.
- f. Taxes: As a private concern the PBC is considered liable for taxation by the host country in accord with whatever treaty arrangements are made. These arrangements are unknown but for analysis purposes an allowance of 45% of profits have been set aside for this purpose. (No carry over for losses has been provided).

3.6.2 Financial Operation

- a. The operation of the recommended PBC is divided into two separate phases. In the first phase the system is operated as a temporary storage facility. This phase covers transportation and temporary

storage activities prior to the year 2000. During this phase the operation can be characterized by the data shown below:

FINANCIAL CHARACTERISTICS FOR TEMPORARY STORAGE PHASE

<u>Item</u>	<u>Amount Dollars</u>
Total Capitalized Investment	1.75 Billion
Annual Sales	310 Million
(Representative Year 1993)	
Annual Net Income After Taxes	45 Million
(Representative Year 1993)	
Annual Taxes Paid	41 Million
(Representative Year 1993)	

In the second phase the system is operated as a total spent fuel center and includes transportation, temporary storage, recovery and permanent storage of waste. This phase is characterized by the following:

FINANCIAL CHARACTERISTICS FOR SPENT FUEL CENTER PHASE

<u>Item</u>	<u>Amount Dollars</u>
Total Capitalized Investment	6.30 Billion
Annual Sales	1.38 Billion
(Representative Year 2015)	
Annual Net Income After Taxes	.45 Billion
(Representative Year 2015)	
Annual Taxes Paid	.43 Billion
(Representative Year 2015)	

- b. Figure 3-5, shows the breakdown of the total capital costs in terms of the functions performed by the PBSFLS. Three sources of funds are available for purchase of these facilities:

Summary of Capital Investment PBSFELS- Preferred Concept

FUNCTION ● CAPITAL ITEM	ITEM TOTAL	FUNCTION TOTAL
TRANSPORTATION ● SHIPS ● CASKS ● CASK MAINTENANCE ● CAPITALIZED INTEREST	0.13 0.22 0.05 0.07	.47 BILLION
INTERIM STORAGE ● WATER BASINS ● SUPPORTING FACILITIES ● LOW LEVEL WASTE ● CAPITALIZED INTEREST	1.30 0.01 0.09 0.16	1.56 BILLION
RECOVERY & WASTE MANAGEMENT ● RECOVERY ● HIGH LEVEL WASTE ● CAPITALIZED INTEREST	1.25 1.35 1.37	3.97 BILLION
PERMANENT WASTE STORAGE ● PACKAGING ● VAULTS	0.08 0.22	.30 BILLION

6.30 BILLION

Figure 3-5
3-61

- 1) Equity capital provided by the owners of the PBSFSL
- 2) Cash provided by PBSFSL operations
- 3) Loans from the financial community and later paid back from cash generated from PBSFSL operations.

Figure 3-6 shows the sources of these funds in the purchase of the 6.3 billion dollars worth of PBSFSL facilities. Note that the maximum investment by the owners in facilities is about \$90 million and maximum indebtedness is \$5 billion.

- c. During the temporary storage phase income is received from the utilities for the service of storage of the spent fuel. Figure 3-7a shows the total income received from fuel shipped to 2000. The income shown in figure 3-7a, is associated with costs for the following functions:

- 1) Transportation
- 2) Temporary storage
- 3) Permanent disposal of recovery waste.

While the function of permanent disposal is not performed during this phase, a charge is made for it upon receipt of the fuel. Figure 3-7b, shows the split of income between these functions. Actual distribution of the income during this period to various parties involved is shown in figure 3-7c

- d. During the spent fuel center phase income is received from utilities as a service charge and from fuel fabricators for the recovered uranium and plutonium products. Figure 3-8a, shows the split of income from these sources. During this phase costs are incurred for the following functions:

Sources of Funds for Facility Acquisition (Preferred Concept)

Figure 3-6
3-63

Disposition of PBC Income During the Temporary Storage Phase (1985 through 2000)

* ORIGINALLY PAID TO BUILDERS FROM EQUITY OR BORROWING AND RETURNED FROM EARNINGS

Disposition of PBC Income During the Spent Fuel Center Phase (2000 through 2030)

NOTE: SERVICE CHARGE 42.35
 FUEL PURCHASE -12.80
 NET CHARGE TO UTILITIES 29.55

a. SOURCES OF INCOME

b. INCOME BY FUNCTION

c. DISPOSITION OF INCOME TO PROJECT PARTICIPANTS

* ORIGINALLY PAID TO BUILDERS FROM EQUITY OR BORROWING AND RETURNED FROM EARNINGS.

- 1) Transportation
- 2) Temporary storage
- 3) Recovery
- 4) Permanent disposal of recovery waste

New fuel being received during this phase does not require temporary storage and no storage charge is levied on this fuel. However a handling fee is levied. Additional costs are being incurred due to the fact that fuel from the temporary storage phase remains in the storage pools until it is recovered.

Figure 3-8b, shows the split of a income between the above functions. Note that during this period the utilities pay a service charge of \$42.35 and receive a payment for the fuel used in recovery of \$12.80. This provides a net charge to the utilities of \$29.55. Actual distribution of income during this period is shown in figure 3-8c.

e. Net cost (or income) to the utilities for spent fuel services are a function of:

- 1) Service charge paid at time of dispatch of spent fuel to the PBSFLS
- 2) Payment received (or charge paid) as result of recovery operations
- 3) Purchase of stock in the PBC
- 4) Dividends received from PBC

Items 3) and 4) depend upon the degree of participation by the utilities in the equity of the PBC. Figure 3-9, summarizes the net cost (or income) over the total period of interest for 0%, 50% and 100% equity participation in the PBC by the utilities providing the spent fuel. As shown, with reprocessing the net is a cost of \$62/KgU at 0% equity participation and is an income of \$66/KgU at 100% participation.

Net Cost to Utilities for Spent Fuel Logistics

% OF PBC OWNED BY UTILITIES	0%	50%	100%
TOTAL DOLLARS IN MILLIONS			
TRANSPORTATION SERVICE CHARGE	2573	2573	2573
TEMPORARY STORAGE SERVICE CHARGE	3812	3812	3812
TEMPORARY STORAGE HANDLING CHARGE	1435	1435	1435
PERMANENT STORAGE SERVICE CHARGE	568	568	568
DIVIDENDS LESS EQUITY PURCHASES (WITHOUT REPROCESSING)	0	-105	-210
CREDIT FOR SPENT FUEL REPROCESSED	-1220	-1220	-1220
DIVIDENDS LESS EQUITY PURCHASES (REPROCESSING)	0	-7270	-14540
NET	7168	-207	-7582
DOLLARS PER KgU SHIPPED			
NET	62 \$/KgU	-2 \$/KgU	-66 \$/KgU
NOTES: COSTS AND INCOMES ARE TOTAL SPENT OVER PERIOD FROM 1980 THROUGH 2030 PER KgU COSTS/INCOMES ARE FOR TOTAL SPENT FUEL PROFILE THROUGH 2030 (i.e. 114,800,000 KgU). NO DISCOUNTING TO PRESENT VALUE.			

Figure 3-9
3-67

f. Figures 3-10a, b, c & d are the yearly cash reports for the PBC. The second column shows the total revenue received by the PBC and is the sum of the service charge and the sale of recovered products. The third column shows the total cash that would be spent by the PBC if all capital purchases were made by the PBC without financing. This column is the sum of operation and maintenance (O&M) expenses and the total cost of capital purchases. The fourth column is the net of the cash transactions of the PBC if operating solely on its own funds. This column is used to set the service charge to the utilities by the following:

Sum of Prest Value of	=	Sum of Present Value
net Cash In		of net Cash Out

For this calculation the service charge of column 2 is adjusted until the rate used in present value calculations become the selected ROI.

In this way the service charge is determined on the basis that the total capital investment should earn at the desired rate regardless of the method of financing. The service charge is therefore independent of financing arrangements.

Figures 3-10, b, c & d also shows another cash line in columns 6 & 7. This is the owners cash line. Minus values in column 6 indicate an equity investment (stock purchase) by the owners. Plus values indicate a dividend to the owners. The cumulative total of the required equity investments is 90 million dollars for all functions.

YEARLY CASH FLOW STATEMENT
DOLLARS IN MILLIONS

UNFINANCED ENTERPRISE BEFORE TAX					OWNERS	
YEAR	ANNUAL CASH IN	ANNUAL CASH OUT	ANNUAL NET CASH	CUM NET CASH	ANNUAL NET CASH	CUM NET CASH
1978	.0	12.0	-12.0	-12.0	-1.2	-1.2
1979	.0	4.6	- 4.6	-16.5	-.5	-1.7
1980	.0	7.6	- 7.6	-24.1	-.8	-2.4
1981	.0	12.0	-12.0	-36.1	-1.2	-3.6
1982	.0	12.0	-12.0	-48.0	-1.2	-4.8
1983	.0	6.8	-6.8	-54.9	-.7	-5.5
1984	.0	1.1	-1.1	-56.0	-.1	-5.6
1985	9.9	68.1	-58.2	-114.2	-11.5	-17.2
1986	11.0	15.8	-4.7	-118.9	-7.9	-25.0
1987	12.3	2.8	9.5	-109.4	-5.1	-30.1
1988	14.8	2.8	12.0	-97.5	-2.6	-32.7
1989	16.9	15.1	1.9	-95.6	-3.7	-36.3
1990	21.0	17.0	4.0	-91.6	-1.8	-38.1
1991	24.8	4.0	20.8	-70.8	3.7	-34.4
1992	28.1	17.6	10.4	-60.4	2.8	-31.7
1993	31.7	16.9	14.8	-45.6	3.8	-27.8
1994	35.5	5.2	30.3	-15.3	7.0	-20.8
1995	38.8	18.9	19.9	4.6	6.0	-14.8
1996	42.4	19.5	23.0	27.5	6.7	-8.1
1997	45.9	20.1	25.8	53.3	7.4	-.7
1998	49.0	8.4	40.6	93.9	9.9	9.3
1999	52.0	19.4	32.6	126.5	9.0	18.3
2000	55.1	10.6	44.5	171.0	11.1	29.4
2001	58.1	21.3	36.8	207.8	10.1	39.5
2002	61.5	22.0	39.6	247.4	10.4	49.9
2003	65.0	9.0	56.0	303.4	13.1	62.9
2004	68.4	21.3	47.1	350.5	11.9	74.8
2005	69.4	29.1	40.4	390.8	20.3	95.1
2006	70.5	16.1	54.4	445.3	22.7	117.8
2007	70.5	9.6	60.9	506.2	23.1	140.9
2008	70.5	9.6	60.9	567.1	22.7	163.6
2009	70.5	14.8	55.7	622.8	22.5	186.1
2010	70.5	16.1	54.4	677.3	22.8	208.9
2011	70.5	9.6	60.9	738.2	23.2	232.1
2012	70.5	16.1	54.4	792.6	22.9	255.1
2013	70.5	16.1	54.4	847.0	23.2	278.3
2014	70.5	9.6	60.9	908.0	23.6	301.9
2015	70.5	18.9	51.6	959.5	22.9	324.8
2016	70.5	16.1	54.4	1014.0	23.6	348.4
2017	70.5	16.1	54.4	1068.4	24.0	372.5
2018	70.5	9.6	60.9	1129.3	24.6	397.0
2019	70.5	14.8	55.7	1185.0	24.4	421.4
2020	70.5	22.6	47.9	1233.0	22.7	444.1
2021	70.5	22.6	47.9	1280.9	22.7	466.8
2022	70.5	16.1	54.4	1335.3	23.7	490.5
2023	70.5	9.6	60.9	1396.2	24.1	514.6
2024	70.5	21.3	49.2	1445.5	22.5	537.1
2025	70.5	35.6	34.9	1480.4	19.8	556.9
2026	70.5	16.1	54.4	1534.8	21.5	578.4
2027	70.5	16.1	54.4	1589.2	20.1	598.5
2028	70.5	17.4	53.1	1642.4	18.1	616.6
2029	70.5	14.8	55.7	1698.1	16.7	633.3
2030	70.5	25.4	45.1	1743.2	7.6	640.9

Figure 3.10a Cash Report for Transportation through 2030

-- Vault Concept --

YEARLY CASH FLOW STATEMENT
DOLLARS IN MILLIONS

UNFINANCED ENTERPRISE BEFORE TAX					OWNERS	
YEAR	ANNUAL CASH IN	ANNUAL CASH OUT	ANNUAL NET CASH	CUM NET CASH	ANNUAL NET CASH	CUM NET CASH
1978	.0	52.4	-52.4	-52.4	-5.3	-5.3
1979	.0	20.0	-20.0	-72.5	-2.0	-7.3
1980	.0	45.9	-45.9	-118.4	-4.7	-12.0
1981	.0	71.1	-71.1	-189.4	-7.2	-19.2
1982	.0	65.9	-65.9	-255.4	-6.7	-25.9
1983	.0	65.3	-65.3	-320.7	-6.7	-32.5
1984	.0	50.5	-50.5	-371.2	-5.2	-37.7
1985	87.0	251.8	-164.8	-536.0	-23.7	-61.4
1986	97.0	79.0	18.0	-518.0	-4.4	-65.8
1987	107.8	89.3	18.6	-499.5	-1.6	-67.4
1988	129.7	114.2	15.5	-484.0	7.9	-59.5
1989	148.8	119.3	29.4	-454.6	15.6	43.9
1990	184.2	123.2	61.0	-393.6	28.9	-15.0
1991	217.8	130.2	87.6	-305.9	40.5	25.5
1992	246.4	143.6	102.7	-203.2	47.9	73.4
1993	278.7	123.2	155.5	-47.7	61.9	135.3
1994	311.9	114.2	197.7	150.0	75.1	210.3
1995	340.4	98.9	241.6	391.5	86.9	297.2
1996	372.7	72.0	300.7	692.2	102.8	400.0
1997	403.2	38.3	364.9	1057.1	119.6	519.6
1998	430.0	29.8	400.2	1457.3	131.6	651.3
1999	456.9	27.2	429.7	1887.0	142.9	794.2
2000	36.9	24.9	11.9	1898.9	-152.8	641.4
2001	38.9	24.7	14.2	1913.2	-150.6	490.7
2002	41.2	24.7	16.5	1929.7	-148.2	342.5
2003	43.5	24.7	18.8	1948.5	-145.8	196.7
2004	45.7	24.7	21.1	1969.5	-143.4	53.3
2005	48.9	24.7	24.2	1993.7	-75.2	-21.8
2006	47.2	24.7	22.5	2016.2	-72.0	-93.8
2007	47.2	24.7	22.5	2038.7	-65.1	-159.0
2008	47.2	24.7	22.5	2061.2	-55.7	-214.7
2009	47.2	24.7	22.5	2083.7	-45.7	-260.4
2010	47.2	24.7	22.5	2106.2	-35.4	-295.8
2011	47.2	24.7	22.5	2128.7	-24.4	-320.2
2012	47.2	24.7	22.5	2151.2	-11.9	-332.1
2013	47.2	24.7	22.5	2173.7	-4.8	-336.8
2014	47.2	24.7	22.5	2196.2	1.4	-335.4
2015	47.2	24.7	22.5	2218.4	6.7	-328.7
2016	47.2	24.7	22.5	2240.9	10.2	-318.6
2017	47.2	24.7	22.5	2263.4	11.1	-307.4
2018	47.2	24.7	22.5	2285.9	11.5	-295.9
2019	47.2	24.7	22.5	2308.4	11.7	-284.3
2020	47.2	24.7	22.5	2330.9	11.7	-272.6
2021	47.2	24.7	22.5	2353.4	11.7	-260.9
2022	47.2	24.7	22.5	2375.9	11.7	-249.2
2023	47.2	24.7	22.5	2398.4	11.7	-237.5
2024	47.2	24.7	22.5	2420.9	11.7	-225.8
2025	47.2	24.7	22.5	2443.4	11.7	-214.2
2026	47.2	24.7	22.5	2465.9	11.7	-202.5
2027	47.2	24.7	22.5	2488.4	11.7	-190.8
2028	47.2	24.7	22.5	2510.9	11.7	-179.1
2029	47.2	24.7	22.5	2533.4	11.7	-167.4
2030	47.2	24.7	22.5	2555.7	11.6	-155.9

Figure 3.10b Cash Report for Temporary Storage through 2030

-- Vault Concept --

YEARLY CASH FLOW STATEMENT
DOLLARS IN MILLIONS

YEAR	UNFINANCED ENTERPRISE BEFORE TAX				OWNERS	
	ANNUAL CASH IN	ANNUAL CASH OUT	ANNUAL NET CASH	CUM NET CASH	ANNUAL NET CASH	CUM NET CASH
1978	.0	.0	.0	.0	.0	.0
1979	.0	.0	.0	.0	.0	.0
1980	.0	.0	.0	.0	.0	.0
1981	.0	.0	.0	.0	.0	.0
1982	.0	.0	.0	.0	.0	.0
1983	.0	.0	.0	.0	.0	.0
1984	.0	.0	.0	.0	.0	.0
1985	.0	.0	.0	.0	.0	.0
1986	.0	.0	.0	.0	.0	.0
1987	.0	.0	.0	.0	.0	.0
1988	.0	.0	.0	.0	.0	.0
1989	.0	.0	.0	.0	.0	.0
1990	.0	.0	.0	.0	.0	.0
1991	.0	104.6	-104.6	-104.6	-10.5	-10.5
1992	.0	104.7	-104.7	-209.3	-10.6	-21.2
1993	.0	340.2	-340.2	-549.5	-34.4	-55.6
1994	.0	209.6	-209.6	-759.2	-21.5	-77.1
1995	.0	340.6	-340.6	-1099.8	-34.9	-112.0
1996	.0	550.2	-550.2	-1650.0	-56.2	-168.2
1997	.0	550.6	-550.6	-2200.6	-56.6	-224.9
1998	.0	315.6	-315.6	-2516.1	-33.3	-258.2
1999	.0	54.6	-54.6	-2570.7	-7.2	-265.4
2000	1038.6	1480.0	-441.4	-3012.2	267.5	2.1
2001	1053.6	61.5	992.1	-2020.0	351.7	353.7
2002	1072.1	61.5	1010.7	-1009.4	358.0	711.8
2003	1090.7	61.5	1029.2	19.8	364.0	1075.8
2004	1101.8	61.5	1040.3	1060.1	365.8	1441.6
2005	1109.2	61.5	1047.7	2107.8	365.3	1806.9
2006	1124.0	61.5	1062.5	3170.3	368.2	2175.1
2007	1142.5	61.5	1081.0	4251.4	372.5	2547.7
2008	1153.6	61.5	1092.2	5343.5	372.5	2920.2
2009	1168.5	61.5	1107.0	6450.5	373.8	3294.0
2010	1183.3	61.5	1121.8	7572.3	374.4	3668.4
2011	1190.7	61.5	1129.2	8701.5	370.5	4038.9
2012	1205.5	61.5	1144.0	9845.5	369.7	4408.7
2013	1220.3	61.5	1158.9	11004.4	368.0	4776.7
2014	1238.9	61.5	1177.4	12181.8	367.4	5144.1
2015	1250.0	61.5	1188.5	13370.3	361.8	5505.9
2016	1264.8	61.5	1203.3	14573.6	357.0	5862.9
2017	1279.6	61.5	1218.1	15791.7	351.0	6213.8
2018	1294.4	61.5	1233.0	17024.7	343.6	6557.4
2019	1305.5	61.5	1244.1	18268.7	332.9	6890.3
2020	1324.1	61.5	1262.6	19531.3	663.1	7553.4
2021	1338.9	61.5	1277.4	20808.7	664.3	8217.6
2022	1350.0	61.5	1288.5	22097.3	670.0	8887.7
2023	1368.5	61.5	1307.1	23404.3	679.7	9567.3
2024	1383.4	61.5	1321.9	24726.2	687.4	10254.7
2025	1398.2	61.5	1336.7	26062.9	695.1	10949.8
2026	1413.0	61.5	1351.5	27414.4	702.8	11652.6
2027	1427.8	61.5	1366.3	28780.7	710.5	12363.1
2028	1442.6	61.5	1381.2	30161.9	718.2	13081.3
2029	1457.5	61.5	1396.0	31557.8	725.9	13807.2
2030	1472.3	61.5	1410.8	32968.6	733.6	14540.8

Figure 3.10c Cash Report for Recovery through 2030

-- Vault Concept --

YEARLY CASH FLOW STATEMENT
DOLLARS IN MILLIONS

YEAR	UNFINANCED ENTERPRISE BEFORE TAX				OWNERS	
	ANNUAL CASH IN	ANNUAL CASH OUT	ANNUAL NET CASH	CUM NET CASH	ANNUAL NET CASH	CUM NET CASH
1978	.0	.0	.0	.0	.0	.0
1979	.0	.0	.0	.0	.0	.0
1980	.0	.0	.0	.0	.0	.0
1981	.0	.0	.0	.0	.0	.0
1982	.0	.0	.0	.0	.0	.0
1983	.0	.0	.0	.0	.0	.0
1984	.0	.0	.0	.0	.0	.0
1985	2.2	.0	2.2	2.2	2.2	2.2
1986	2.4	.0	2.4	4.6	2.4	4.6
1987	2.7	.0	2.7	7.3	2.7	7.3
1988	3.3	.0	3.3	10.6	3.3	10.6
1989	3.7	.0	3.7	14.3	3.7	14.3
1990	4.6	.0	4.6	19.0	4.6	19.0
1991	5.5	.0	5.5	24.4	5.5	24.4
1992	6.2	.0	6.2	30.6	6.2	30.6
1993	7.0	19.7	-12.7	17.9	5.1	35.7
1994	7.8	7.5	.3	18.2	5.4	41.1
1995	8.6	12.2	-3.7	14.6	6.0	46.1
1996	9.4	19.7	-10.4	4.2	4.0	50.1
1997	10.1	19.8	-9.6	-5.4	3.1	53.2
1998	10.8	11.3	-.5	-5.9	2.9	56.1
1999	11.5	1.9	9.5	3.6	3.5	59.6
2000	12.2	20.7	-8.5	-5.0	-7.6	52.1
2001	12.8	20.1	-7.2	-12.2	-6.3	45.8
2002	13.6	14.5	-.9	-13.1	-5.9	39.9
2003	14.3	16.6	-2.3	-15.4	-5.8	34.0
2004	15.1	20.1	-5.0	-20.4	-6.1	28.0
2005	15.3	20.1	-4.8	-25.2	-6.8	21.2
2006	15.6	16.2	-.7	-25.8	-7.1	14.1
2007	15.6	11.9	3.6	-22.2	-7.3	6.9
2008	15.6	11.9	3.6	-18.6	-7.5	-.6
2009	15.6	11.1	4.5	-14.1	-7.6	-8.3
2010	15.6	20.1	-4.6	-18.6	-8.7	-17.0
2011	15.6	14.5	1.0	-17.6	-9.2	-26.2
2012	15.6	16.7	-1.1	-18.7	-9.9	-36.1
2013	15.6	20.1	-4.6	-23.2	-11.0	-47.2
2014	15.6	20.1	-4.6	-27.8	-12.1	-59.3
2015	15.6	16.2	-.7	-28.5	-12.8	-72.1
2016	15.6	11.9	3.6	-24.9	-13.1	-85.2
2017	15.6	11.9	3.6	-21.3	-13.4	-98.5
2018	15.6	11.1	4.5	-16.8	-11.9	-110.4
2019	15.6	20.1	-4.6	-21.4	-12.7	-123.1
2020	15.6	22.3	-6.8	-28.2	-13.4	-136.6
2021	15.6	16.7	-1.1	-29.3	-12.7	-149.3
2022	15.6	20.1	-4.6	-33.9	-12.7	-162.0
2023	15.6	20.2	-4.6	-38.5	-13.6	-175.7
2024	15.6	16.3	-.7	-39.3	-14.7	-190.4
2025	15.6	12.0	3.6	-35.7	-14.2	-204.6
2026	15.6	12.0	3.6	-32.1	-13.9	-218.5
2027	15.6	11.1	4.4	-27.7	-14.0	-232.5
2028	15.6	11.1	4.4	-23.3	-14.0	-246.5
2029	15.6	11.1	4.4	-18.8	-14.1	-260.6
2030	15.6	11.1	4.4	-14.4	-15.1	-275.7

Figure 3.10d Cash Report for Permanent Storage Through 2030

-- Vault Concept --

Figures 3-11, b, c & d show profit and loss report for each of the years of operation. These reports are based upon the service charge previously determined and takes into account interest on capital loans, depreciation and taxation to provide a realistic performance estimate of profit and loss for the baseline PBC.

DOLLARS IN MILLIONS

YEAR	REP REVENUE	SERV CH REVENUE	TOTAL REVENUE	OPER EXPEN	INT EXPEN	DEP EXPEN	TOTAL EXPEN	TAXES	NET INCOME
1978	.0	.0	.0	.0	.0	.0	.0	.0	-.0
1979	.0	.0	.0	.0	.0	.1	.1	.0	-.1
1980	.0	.0	.0	.0	.0	.1	.1	.0	-.1
1981	.0	.0	.0	.0	.0	.1	.1	.0	-.1
1982	.0	.0	.0	.0	.0	.2	.2	.0	-.2
1983	.0	.0	.0	.0	.0	.2	.2	.0	-.2
1984	.0	.0	.0	.0	.0	.2	.2	.0	-.2
1985	.0	9.9	9.9	2.2	11.2	6.1	19.5	.0	-9.6
1986	.0	11.0	11.0	2.8	12.2	6.7	21.7	.0	-10.7
1987	.0	12.3	12.3	2.8	12.0	6.7	21.5	.0	-9.2
1988	.0	14.8	14.8	2.8	11.7	6.7	21.2	.0	-6.5
1989	.0	16.9	16.9	3.4	12.5	7.3	23.1	.0	-6.2
1990	.0	21.0	21.0	4.0	13.3	7.9	25.3	.0	-4.3
1991	.0	24.8	24.8	4.0	12.9	7.9	24.9	.0	-.1
1992	.0	28.1	28.1	4.6	13.7	8.6	26.9	.6	.6
1993	.0	31.7	31.7	5.2	14.2	9.2	28.6	1.5	1.6
1994	.0	35.5	35.5	5.2	13.7	9.2	28.1	3.6	3.9
1995	.0	38.8	38.8	5.9	14.2	9.8	29.9	4.2	4.6
1996	.0	42.4	42.4	6.5	14.7	10.5	31.7	5.2	5.6
1997	.0	45.9	45.9	7.1	15.1	11.1	33.4	6.0	6.5
1998	.0	49.0	49.0	7.1	14.4	11.2	32.6	7.8	8.5
1999	.0	52.0	52.0	7.7	14.4	11.8	33.9	8.7	9.4
2000	.0	55.1	55.1	7.7	13.6	11.9	33.2	10.5	11.4
2001	.0	58.1	58.1	8.3	13.6	12.6	34.5	11.4	12.3
2002	.0	61.5	61.5	9.0	13.4	13.2	35.6	12.5	13.5
2003	.0	65.0	65.0	9.0	11.9	13.2	34.1	14.8	16.0
2004	.0	68.4	68.4	9.6	11.3	13.8	34.7	16.2	17.5
2005	.0	69.4	69.4	9.6	11.2	8.7	29.5	19.1	20.7
2006	.0	70.5	70.5	9.6	11.1	8.4	29.1	19.9	21.5
2007	.0	70.5	70.5	9.6	10.4	8.4	28.4	20.2	21.9
2008	.0	70.5	70.5	9.6	9.7	8.4	27.7	20.6	22.3
2009	.0	70.5	70.5	9.6	9.4	8.1	27.0	20.9	22.6
2010	.0	70.5	70.5	9.6	9.2	7.7	26.5	21.1	22.9
2011	.0	70.5	70.5	9.6	8.5	7.7	25.8	21.5	23.2
2012	.0	70.5	70.5	9.6	8.3	7.4	25.3	21.7	23.5
2013	.0	70.5	70.5	9.6	8.1	7.2	24.9	21.9	23.7
2014	.0	70.5	70.5	9.6	7.4	7.2	24.2	22.2	24.1
2015	.0	70.5	70.5	9.6	7.5	7.1	24.2	22.2	24.1
2016	.0	70.5	70.5	9.6	7.3	6.9	23.8	22.4	24.3
2017	.0	70.5	70.5	9.6	7.2	6.7	23.5	22.5	24.4
2018	.0	70.5	70.5	9.6	6.6	6.7	22.8	22.9	24.8
2019	.0	70.5	70.5	9.6	6.3	6.5	22.4	23.1	25.0
2020	.0	70.5	70.5	9.6	6.8	7.6	23.9	22.3	24.2
2021	.0	70.5	70.5	9.6	7.2	8.2	25.0	21.8	23.7
2022	.0	70.5	70.5	9.6	7.0	8.3	24.9	21.9	23.7
2023	.0	70.5	70.5	9.6	6.3	8.3	24.1	22.3	24.1
2024	.0	70.5	70.5	9.6	6.5	9.4	25.4	21.6	23.4
2025	.0	70.5	70.5	9.6	7.9	12.7	30.2	19.3	20.9
2026	.0	70.5	70.5	9.6	7.4	13.7	30.6	19.1	20.7
2027	.0	70.5	70.5	9.6	6.7	15.3	31.6	18.7	20.2
2028	.0	70.5	70.5	9.6	5.9	17.9	33.4	17.8	19.3
2029	.0	70.5	70.5	9.6	4.6	20.3	34.4	17.3	18.8
2030	.0	70.5	70.5	9.6	3.8	35.8	49.1	10.2	11.1
TOTAL	.0	2573.8	2573.8	363.4	462.4	467.2	1293.2	637.4	643.1
AVG	.0	48.6	48.6	6.9	8.7	8.8	24.4	12.0	12.1
\$/KG	.0	22.4	22.4	3.2	4.0	4.1	11.3	5.6	5.6

Figure 3.11a Profit and Loss Report for Transportation through 2030

-- Vault Concept --

DOLLARS IN MILLIONS

YEAR	HANDLING FEE REVENUE	SERV CH REVENUE	TOTAL REVENUE	OPER EXPEN	INT EXPEN	DEP EXPEN	TOTAL EXPEN	TAXES	NET INCOME
1978	.0	.0	.0	.0	.0	.2	.2	.0	-.2
1979	.0	.0	.0	.0	.0	.3	.3	.0	-.3
1980	.0	.0	.0	.1	.0	.4	.5	.0	-.5
1981	.0	.0	.0	.1	.0	.8	.8	.0	-.8
1982	.0	.0	.0	.1	.0	1.0	1.2	.0	-1.2
1983	.0	.0	.0	.1	.0	1.3	1.5	.0	-1.5
1984	.0	.0	.0	.1	.0	1.6	1.7	.0	-1.7
1985	.0	87.0	87.0	24.7	55.3	29.6	109.6	.0	-22.6
1986	.0	97.0	97.0	24.7	59.2	32.3	116.2	.0	-19.2
1987	.0	107.8	107.8	24.7	63.9	35.6	124.1	.0	-16.3
1988	.0	129.7	129.7	24.7	70.6	40.0	135.3	.0	-5.6
1989	.0	148.8	148.8	24.7	77.5	44.8	146.9	.9	1.0
1990	.0	184.2	184.2	24.7	84.4	49.7	158.7	12.2	13.2
1991	.0	217.8	217.8	24.7	91.6	55.0	171.2	22.4	24.3
1992	.0	246.4	246.4	24.7	99.6	60.9	185.2	29.4	31.8
1993	.0	278.7	278.7	24.7	105.3	65.8	195.8	39.8	43.1
1994	.0	311.9	311.9	24.7	109.7	70.3	204.7	51.5	55.7
1995	.0	340.4	340.4	24.7	112.3	74.0	211.0	62.2	67.3
1996	.0	372.7	372.7	24.7	111.9	76.4	212.9	76.7	83.1
1997	.0	403.2	403.2	24.7	107.9	77.1	209.6	92.9	100.7
1998	.0	430.0	430.0	24.7	102.6	77.3	204.6	108.2	117.2
1999	.0	456.9	456.9	24.7	96.5	77.5	198.6	124.0	134.3
TOTAL	.0	3811.7	3811.7	371.0	1348.3	871.9	2590.6	619.3	601.8
\$/KgU	.0	196.8	196.8	19.2	69.6	45.0	133.8	32.0	31.0

Figure 3.11b Profit and Loss Report for Temporary Storage
through 2000

-- Vault Concept --

DOLLARS IN MILLIONS

YEAR	REP REVENUE	SERV CH REVENUE	TOTAL REVENUE	OPER EXPEN	INT EXPEN	DEP EXPEN	TOTAL EXPEN	TAXES	NET INCOME
1978	.0	.0	.0	.0	.0	.0	.0	.0	.0
1979	.0	.0	.0	.0	.0	.0	.0	.0	.0
1980	.0	.0	.0	.0	.0	.0	.0	.0	.0
1981	.0	.0	.0	.0	.0	.0	.0	.0	.0
1982	.0	.0	.0	.0	.0	.0	.0	.0	.0
1983	.0	.0	.0	.0	.0	.0	.0	.0	.0
1984	.0	.0	.0	.0	.0	.0	.0	.0	.0
1985	.0	.0	.0	.0	.0	.0	.0	.0	.0
1986	.0	.0	.0	.0	.0	.0	.0	.0	.0
1987	.0	.0	.0	.0	.0	.0	.0	.0	.0
1988	.0	.0	.0	.0	.0	.0	.0	.0	.0
1989	.0	.0	.0	.0	.0	.0	.0	.0	.0
1990	.0	.0	.0	.0	.0	.0	.0	.0	.0
1991	.0	.0	.0	.1	.0	.4	.4	.0	-.4
1992	.0	.0	.0	.2	.0	.7	.9	.0	-.9
1993	.0	.0	.0	.4	.0	2.0	2.4	.0	-2.4
1994	.0	.0	.0	.6	.0	2.8	3.4	.0	-3.4
1995	.0	.0	.0	.8	.0	4.1	5.0	.0	-5.0
1996	.0	.0	.0	1.3	.0	6.4	7.7	.0	-7.7
1997	.0	.0	.0	1.7	.0	8.8	10.5	.0	-10.5
1998	.0	.0	.0	1.9	.0	10.2	12.2	.0	-12.2
1999	.0	.0	.0	2.0	.0	10.5	12.5	.0	-12.5
2000	1077.8	-39.2	1038.6	61.5	368.3	195.0	624.8	198.6	215.2
2001	1093.0	-39.4	1053.6	61.5	361.9	195.0	618.4	208.9	226.3
2002	1111.5	-39.4	1072.1	61.5	354.8	195.0	611.3	221.2	239.6
2003	1130.0	-39.4	1090.7	61.5	347.0	195.0	603.5	233.8	253.3
2004	1141.1	-39.4	1101.8	61.5	338.5	195.0	594.9	243.3	263.6
2005	1148.6	-39.4	1109.2	61.5	329.1	195.0	585.5	251.3	272.3
2006	1163.4	-39.4	1124.0	61.5	318.7	195.0	575.2	263.4	285.4
2007	1181.9	-39.4	1142.5	61.5	307.3	195.0	563.8	277.8	300.9
2008	1193.0	-39.4	1153.6	61.5	294.8	195.0	551.3	289.1	313.2
2009	1207.8	-39.4	1168.5	61.5	281.0	195.0	537.5	302.9	328.1
2010	1222.6	-39.4	1183.3	61.5	265.8	195.0	522.3	317.3	343.7
2011	1230.1	-39.4	1190.7	61.5	249.1	195.0	505.6	328.8	356.2
2012	1244.9	-39.4	1205.5	61.5	230.8	195.0	487.3	344.8	373.5
2013	1259.7	-39.4	1220.3	61.5	210.6	195.0	467.1	361.6	391.7
2014	1278.2	-39.4	1238.9	61.5	188.4	195.0	444.9	381.1	412.9
2015	1289.3	-39.4	1250.0	61.5	164.0	195.0	420.5	398.2	431.3
2016	1304.2	-39.4	1264.8	61.5	137.1	195.0	393.6	418.2	453.0
2017	1319.0	-39.4	1279.6	61.5	107.6	195.0	364.1	439.5	476.1
2018	1333.8	-39.4	1294.4	61.5	75.1	195.0	331.6	462.2	500.7
2019	1344.9	-39.4	1305.5	61.5	39.3	195.0	295.8	484.7	525.1
2020	1363.4	-39.4	1324.1	61.5	.0	.0	61.5	606.0	656.5
2021	1378.3	-39.4	1338.9	61.5	.0	.0	61.5	613.2	664.3
2022	1389.4	-39.4	1350.0	61.5	.0	.0	61.5	618.5	670.0
2023	1407.9	-39.4	1368.5	61.5	.0	.0	61.5	627.4	679.7
2024	1422.7	-39.4	1383.4	61.5	.0	.0	61.5	634.5	687.4
2025	1437.5	-39.4	1398.2	61.5	.0	.0	61.5	641.6	695.1
2026	1452.4	-39.4	1413.0	61.5	.0	.0	61.5	648.7	702.8
2027	1467.2	-39.4	1427.8	61.5	.0	.0	61.5	655.8	710.5
2028	1482.0	-39.4	1442.6	61.5	.0	.0	61.5	663.0	718.2
2029	1496.8	-39.4	1457.5	61.5	.0	.0	61.5	670.1	725.9
2030	1511.6	-39.4	1472.3	61.5	.0	.0	61.5	677.2	733.6
TOTAL	40084.0	-1220.2	38863.8	1914.8	4969.1	3946.2	10830.0	13482.5	14551.1
AVG	756.3	-23.0	733.3	36.1	93.8	74.5	204.3	254.4	274.5
\$/KG	349.0	-10.6	338.4	16.7	43.3	34.4	94.3	117.4	126.7

Figure 3.11c Profit and Loss Report for Recovery through 2030

-- Vault Concept --

DOLLARS IN MILLIONS

YEAR	REP REVENUE	SERV CH REVENUE	TOTAL REVENUE	OPER EXPEN	INT EXPEN	DEP EXPEN	TOTAL EXPEN	TAXES	NET INCOME
1978	.0	.0	.0	.0	.0	.0	.0	.0	.0
1979	.0	.0	.0	.0	.0	.0	.0	.0	.0
1980	.0	.0	.0	.0	.0	.0	.0	.0	.0
1981	.0	.0	.0	.0	.0	.0	.0	.0	.0
1982	.0	.0	.0	.0	.0	.0	.0	.0	.0
1983	.0	.0	.0	.0	.0	.0	.0	.0	.0
1984	.0	.0	.0	.0	.0	.0	.0	.0	.0
1985	.0	2.2	2.2	.0	.0	.0	.0	.0	2.2
1986	.0	2.4	2.4	.0	.0	.0	.0	.0	2.4
1987	.0	2.7	2.7	.0	.0	.0	.0	.0	2.7
1988	.0	3.3	3.3	.0	.0	.0	.0	.0	3.3
1989	.0	3.7	3.7	.0	.0	.0	.0	.0	3.7
1990	.0	4.6	4.6	.0	.0	.0	.0	.0	4.6
1991	.0	5.5	5.5	.0	.0	.0	.0	.0	5.5
1992	.0	6.2	6.2	.0	.0	.0	.0	.0	6.2
1993	.0	7.0	7.0	.0	1.4	.8	2.2	.0	4.8
1994	.0	7.8	7.8	.0	1.9	1.1	3.0	.0	4.8
1995	.0	8.6	8.6	.0	2.7	1.6	4.3	.0	4.2
1996	.0	9.4	9.4	.0	4.0	2.4	6.4	.0	2.9
1997	.0	10.1	10.1	.1	5.3	3.1	8.5	.0	1.6
1998	.0	10.8	10.8	.1	6.0	3.6	9.7	.0	1.1
1999	.0	11.5	11.5	.1	6.0	3.7	9.8	.0	1.7
2000	.0	12.2	12.2	9.2	6.7	4.1	20.1	.0	-7.9
2001	.0	12.8	12.8	9.2	7.3	4.6	21.1	.0	-8.3
2002	.0	13.6	13.6	9.2	7.5	4.8	21.5	.0	-7.9
2003	.0	14.3	14.3	9.2	7.9	5.1	22.1	.0	-7.8
2004	.0	15.1	15.1	9.2	8.4	5.5	23.1	.0	-8.1
2005	.0	15.3	15.3	9.2	8.9	5.9	24.1	.0	-8.8
2006	.0	15.6	15.6	9.2	9.1	6.2	24.6	.0	-9.0
2007	.0	15.6	15.6	9.2	9.0	6.3	24.6	.0	-9.1
2008	.0	15.6	15.6	9.2	8.9	6.4	24.6	.0	-9.0
2009	.0	15.6	15.6	9.2	8.7	6.5	24.4	.0	-8.9
2010	.0	15.6	15.6	9.2	9.1	7.1	25.4	.0	-9.8
2011	.0	15.6	15.6	9.2	9.0	7.3	25.6	.0	-10.0
2012	.0	15.6	15.6	9.2	9.1	7.7	26.0	.0	-10.5
2013	.0	15.6	15.6	9.3	9.4	8.3	26.9	.0	-11.4
2014	.0	15.6	15.6	9.3	9.6	8.9	27.8	.0	-12.2
2015	.0	15.6	15.6	9.3	9.4	9.4	28.1	.0	-12.5
2016	.0	15.6	15.6	9.3	8.9	9.6	27.8	.0	-12.2
2017	.0	15.6	15.6	9.3	8.4	9.7	27.4	.0	-11.8
2018	.0	15.6	15.6	9.3	7.7	9.1	26.1	.0	-10.5
2019	.0	15.6	15.6	9.3	7.7	9.7	26.7	.0	-11.2
2020	.0	15.6	15.6	9.3	7.9	10.4	27.5	.0	-12.0
2021	.0	15.6	15.6	9.3	7.6	10.4	27.2	.0	-11.7
2022	.0	15.6	15.6	9.3	7.5	10.8	27.6	.0	-12.0
2023	.0	15.6	15.6	9.3	7.5	11.7	28.4	.0	-12.9
2024	.0	15.6	15.6	9.3	7.1	12.6	29.0	.0	-13.4
2025	.0	15.6	15.6	9.3	6.3	12.6	28.2	.0	-12.6
2026	.0	15.6	15.6	9.3	5.5	12.7	27.5	.0	-11.9
2027	.0	15.6	15.6	9.3	4.6	12.9	26.8	.0	-11.3
2028	.0	15.6	15.6	9.3	3.6	13.2	26.1	.0	-10.6
2029	.0	15.6	15.6	9.3	2.5	13.7	25.6	.0	-10.0
2030	.0	15.6	15.6	9.3	1.4	15.1	25.8	.0	-10.3
TOTAL	.0	567.9	567.9	287.5	259.5	294.8	841.8	.0	- 273.9
AVG	.0	10.7	10.7	5.4	4.9	5.6	15.9	.0	- 5.2
\$/KG	.0	4.9	4.9	2.5	2.3	2.6	7.3	.0	- 2.4

Figure 3.11d Profit and Loss Report for Permanent Storage through 2030

-- Vault Concept --

4.0 PBSFLS PROGRAM IMPLEMENTATION

4.1 INTRODUCTION

Implementation of a PBSFLS program requires the mutual interest and cooperation of Japan and the U.S. as well as eventual participation by other Pacific Basin countries. In addition, concurrence and cooperation will have to be achieved at the international level (i.e., INFCE, IAEA, etc.).

The PBSFLS implementation program described in this section reflects an ambitious program supportive of the preferred PBSFLS concept described in Section 3.

4.2 PROJECT SCHEDULE

a. Main Project Milestones:

The start of PBSFSL operations at the beginning of 1985 is established as the Key Project Milestone. The PBSFSL concept calls for start of operations with a complement of ships and casks and a water basin (see Section 3). It is considered that the minimum time for design, construction, and licensing of this startup facility is five years. Backing off the 5 years from operational start date at the beginning of 1985 results in the requirement for formation of the Pacific Basin Consortium (PBC) by the beginning of 1980. This leaves a year and a half between then and start of negotiations in mid 1978 to form the organization. An additional milestone is the start of recovery and permanent disposal operations by 2000. These milestones are shown in figure 4-1.

b. Project Phases:

The project milestones form the framework around which the implementation program fits. The preferred project milestones suggest a three phased implementation program including:

- 1) Study Phase
- 2) Project Formulation Phase
- 3) Acquisition Phase

The study phase is intended to:

- 1) determine that a need exists for a PBSFSL.
- 2) determine the requirements which the system must meet.
- 3) develop a concept that meets the requirements; and
- 4) obtain an expression of interest from both Japan and the U.S. with regard to proceeding into a Project Formulation Phase.

Project Schedule

Figure 4-1
4-3

The GSFLS study effort is working towards completion of the first three objectives. Should the necessary expressions of interest be obtained (item 4), the Project Formulation Phase can begin.

The Project Formulation Phase is intended to:

- 1) confirm that a basis of agreement exists between Japan and the U.S.
- 2) develop specific agreements as to the project between Japan, the U.S., and other participants.
- 3) form the PBC as an entity and develop the associated regulatory and control mechanisms.
- 4) define the preliminary design of the PBSFLS in sufficient detail to serve as a basis for contracting detail design and construction.

The Acquisition Phase provides for detail design, construction, and licensing of the PBSFLS. As the PBSFLS is considered to be a growing facility this activity will continue throughout the life of the project. Major design activities occur in the period prior to 1985 for the spent fuel storage facilities and again prior to 2000 for the recovery and permanent disposal facilities.

c. Major Project Decisions:

The PBSFLS project will involve an expenditure of several billions of dollars thus requiring that numerous agreements be reached over its lifetime. Therefore, it is necessary that there be numerous decision points throughout the program. At each decision point the progress accomplished during the last period and perceived project status will be reviewed. This review will result in one of three decisions namely:

- 1) continue on with the program as planned,
- 2) delay while some particular problem is resolve, or
- 3) abandon the project.

Major project decisions are shown in Figure 4-1.

4.3 PROJECT FUNDING REQUIREMENTS

The project decision points shown in figure 4-1 are the key control points for funding. At each point a commitment is made for a specific task of work and for a specific funds expenditures. During the early phases of the program there will be more uncertainty than in later phases. Consequently the early decision points involve smaller funds commitments, thus allowing the uncertainties to be worked out prior to the larger funds commitments as follows:

- a) Decision to initiate study: The U.S. government's decision to initiate the GSFLS study was a commitment to undertake the tasks of preliminarily determining needs, assessing alternatives, selecting preferred concepts, and developing an implementation plan.
- b) Expression of interest: Expressions of interest by both Japan and the U.S. is the next necessary decision. These decisions represent only that the GSFLS study results have been reviewed with the conclusion that a regimed fuel cycle center concept such as the PBSFLS may be beneficial to both countries. No additional commitment of funds would be required, but both countries would agree to work toward the definition of the effort to be done during the formulation phase.
- c) Decision to form the project: This decision would follow the definition and acceptance of the work statement and schedule for the formulation phase. It is estimated that this phase would involve an estimated expenditure of 2 to 4 million dollars over the year and a half period and would require some organizational structure dedicated to the project. As this is the formulation period it might

be desirable for formulation funds to be committed at 6 month intervals. This would provide additional decision points to assure that the program progresses in this critical period to the satisfaction of both governments.

- d) Decision to acquire AFR capability: This decision is made after the formulation phase has resulted in a specific set of international agreements, establishment of the PBC entity, establishment of the regulatory & control mechanism, and definition of the specifications and preliminary design of the PBSFLS. The commitment would include contracts with suitable engineering and construction organization. The commitment is for a \$720 million capital program through 1985, however a significant portion of this would be borrowed funds. The equity portion, or new capital required, would be about \$80 million by 1985.

- e) Decision to expand the AFR capability: The initial AFR capability would include a single water basin. Additional water basins would be required as the demand increases. The estimated construction schedule would provide 18 additional basins constructed between 1985 and 2000. Also required are additional ships and casks. Funds for these capital projects would be committed as the need arises.

Each decisions would be based upon an assurance of the market, confidence in the pricing mechanism, and expectation of expedient licensing. These expenditures would be of relatively low risk. The total commitment for AFR expansion to 2000 is expected to be about \$1 billion. However, most of this commitment would come from borrowing and from the PBC's cash flow.

f) Decision to acquire recovery capability: The business decision to acquire recovery capability necessarily follows the political decision on the acceptability of recovery processes in terms of the non-proliferation objectives. The preferred concept considers the case where these decisions are affirmative and recovery operation begins in 2000. The decision to acquire this capability represents a commitment of expenditures of approximately \$4 billion. The deferral of the decision to 1990, while being included as a non-proliferation consideration, has several beneficial effects in terms of the funding decision. These include:

- 1) Technology should improve in the 10 to 15 year deferral period.
- 2) Licensing should be less uncertain. This is due to better developed regulations, development of a working relationship between the PBC and its regulatory agency, and the resolution of present non-proliferation concerns.
- 3) Funding should be easier to obtain. At the decision point the PBC will have been in operation for 5 years and is estimated to be in a profitable position. The cash flow of the PBC during the construction period from 1990 to 2000 should be sufficient to provide the required equity capital. If recovery were initiated at the beginning of the project an additional \$265 million of equity capital might be required.
- 4) The value of the recovered products should be higher due to increased scarcity of the raw material.

- g) Decision to acquire permanent storage capability: This decision may be made following the decision on whether or not to recover useful products from the spent fuel. The deferral period should allow data to be developed as to whether geologic repositories or air cooled vaults will be used and whether or not the facilities should be co-located with the PBSFSLs. The preferred concept considers use of air cooled vaults. Four vaults are constructed in the period between 1990 and 2030. A total commitment of about \$295 million would be required.

Figures 4-2 and 4-3 show the buildup of funds commitment in relation to the major project decisions.

Equity Investments Required For Independent Functions of PBC

Figure 4-2a

Buildup of External Funds Commitments

Figure 4-2b

Buildup of Total Project Funds Commitments

Figure 4-3

4.4 PROJECT FORMULATION PHASE IMPLEMENTATION

The Project Formulation Phase has been divided into two separate types of activities namely:

- 1) Institutional formulation of the project including negotiating agreements between prospective participants (governmental and non-governmental), formulation of the PBC entity and development of the regulating and non-proliferation control structures for the project.
- 2) Technical definition of the project including
 - a) Support to the institutional activity in the form of continuing financial studies, technical evaluation of regulatory provisions, and technical evaluation of various candidate sites; and
 - b) technical definition of the PBSFLS to the point that an Acquisition Phase may be started. This would include specifications, preliminary designs, cost estimates, program plans and schedules. Some of this activity might normally follow formation of the PBC. However, to preserve the capability of a 1985 operations start date it is considered necessary that this activity be done in parallel with the PBC formulation.

These activities are discussed in more detail in the following subsections.

4.4.1 Institutional Implementation of a Pacific Basin Spent Fuel Consortium

The research would indicate that the institutional implementation of the Basin spent fuel storage consortium involves a two-phase program approach. The first phase would include a 1978-80 negotiation period to put the institutional cadre into place. At the end of the negotiation phase, the terms and principles of a government-to-government treaty (laid down by the U.S. and Japan, and later extended to other cooperating nations) should be agreed upon by all sponsoring and cooperating nations. Signature and ratification of the Treaty by the parties should be completed by 1981 at the latest. The second phase would support the technical development program to put the regional spent fuel logistical system into operation by 1985-86.

Institutional Cadre Development

The institutional development plan includes three basic activity areas*that have to be performed in parallel to complete treaty negotiations by the 1980 milestone. Activity 1 defines the basis for agreement and drafts the Treaty. Activity 1 is responsible for (1) defining the framework (i.e., guidelines, principles, and policy options) for the other two Activities, and (2) managing, controlling, and integrating the outputs of the latter over the phase 1 period to prepare and complete a draft-form treaty by 1980.

Activity 2 develops control and siting regimes for Activity 1 under the guidance of the latter. Activity 2 has a twofold responsibility: (1) design the multinational control system to be put into place for the Pacific Basin consortium, and (2) identify the siting regime and attendant regulatory options linked with site selection and consortium operations concerning environmental, health, and safety aspects.

Activity 3 develops the national and multinational enterprises for Activity 1 under the guidance of the latter. Activity 3 has

*See Figure 4-4

a threefold responsibility (which can be performed jointly (i.e., U.S. -Japan) or separately according to activity areas): (1) define the organization of national (U.S., Japanese) enterprises and launch the two enterprises for consortium formation, (2) define organization and participation structure for the multinational consortium, and (3) develop an ad hoc contracting capability (for the 1980-81 period) that would bind the consortium. This contracting capability would function as a safety valve in case of program slippage beyond the 1980 milestone that would impact on the phase 2 program.

As shown in the Figure 4-5 through 4-7, Activity 1, 2, and 3 are programmatically broken down into key steps. Figure 4-8 identifies the scheduling and program milestones for the institutional program planning phase. Each Activity 1, 2, and 3, with their respective tasks force breakdown structure have been laid down programmatically. The associated scheduling is seen in Figure 4-8.

Programmatic Breakdown for Institutional Development Plan

ACTIVITY BREAKDOWN	PRIMARY FUNCTION	PRIMARY RESPONSIBILITY
ACTIVITY I	DEFINE BASIS OF AGREEMENT AND DRAFT TREATY	PROJECT MANAGEMENT OF TREATY
ACTIVITY II	DEVELOP CONTROL AND SITING REGIMES	DEVELOPE CONTROL AND SITING OPTIONS FOR ACTIVITY I
ACTIVITY III	DEVELOP NATIONAL AND MULTINATIONAL ENTERPRISE CONCEPTS	DEVELOP ENTERPRISE CONCEPTS FOR ACTIVITY I

Figure 4-4

Define Basis of Agreement and Draft Treaty

ACTIVITY 1

Figure 4-5

Develop Control and Siting Regimes

ACTIVITY 2

PROGRAMMATIC STEPS FOR TREATY IMPLEMENTATION

Figure 4-6
4-18

Develop National and Multinational Enterprise Concepts

ACTIVITY 3

INPUTS OF
DOE/DEPT. OF STATE
INITIATIVE STATEMENT
(RESULTS OF STEP 1/
ACTIVITY 1)

STEP 2

PRIVATE SECTOR
PARTICIPATION TO
CONCEPT FORMATION

STEP 3

BILATERAL OR
NATIONAL CONSENSUS
ON ENTERPRISE
CONCEPTS

STEP 4

MULTINATIONAL
CONSULTATION FOR
CONSORTIUM
FORMATION AND
LEGAL ACTION FOR
NATIONAL CONCEPTS

STEP 5

IMPLEMENTATION OF
NATIONAL (AND OTHER
FOUNDING) ENTERPRISES
AND DOCUMENT
FOR TREATY DRAFT

PROGRAMMATIC STEPS FOR TREATY IMPLEMENTATION

WORKING GROUPS/WORK BREAKDOWN

MULTINATIONAL ENTERPRISE
WORKING GROUP:

- FORMATION OPTIONS
- RELATIONS WITH NATIONAL ENTERPRISES
- CORPORATE STRUCTURE, ROLES AND FUNCTIONS
- OWNERSHIP STRUCTURE
- FINANCING
- IMPLEMENTATION

U.S. NATIONAL ENTERPRISES WORKING GROUP:

- FORMATION OPTIONS
- CHOICE OF LEAD COMPANY
- PARTICIPATION STRUCTURE
- ENABLING LEGISLATION (AS/IF REQUIRED)
- FINANCING
- IMPLEMENTATION

JAPANESE NATIONAL ENTERPRISE WORKING GROUP:

- FORMATION OPTIONS
- CHOICE OF LEAD COMPANY (IF ANY)
- PARTICIPATION STRUCTURE
- LEGAL/REGULATORY ASPECTS
- FINANCING
- IMPLEMENTATION

U.S./JAPANESE COMMISSION FOR AD HOC CONTRACTING CAPABILITY:

- AUTHORITY TO COMMIT
- CONDITIONS FOR COMMITMENT
- FINANCIAL RESOURCES
- BINDING SITUATION FOR PBC

○ PRELIMINARY DOCUMENT

OR

ITERATIVE PROCESS

DECISION IN PRINCIPLE

FINAL DECISION

INTERIM DOCUMENT

FINAL DOCUMENT

LAUNCHING OF ENTERPRISE, OR AD HOC CONTRACTING CAPABILITY

Figure 4-7
4-19

Institutional Development Plan

Figure 4-8
4-20

4.4.2 Technical Definition Activity

Figure 4-9 shows the technical task items which should be accomplished during the PBSFSL Project Formulation Phase in order that PBSFSL design and construction activities can begin at the start of 1980. Each task is discussed in the following paragraphs.

1. Technical/Financial Support to Institutional Formulation

a) Improved design concepts:

The GSFLS study developed selected systemized and modularized components for evaluating various integrated GSFLS concepts. These results will be further analyzed and evaluated to determine their optimality in regards to size, plant throughput, and major subsystem design. The modules which would be candidates for this analysis would be the cask, ship, cask maintenance, cask receiving, water basins and low level waste process facilities.

b) Construction concepts:

Item (a) developed improved concepts. The purpose of this task will be to evaluate different techniques for fabricating modular components. This would be done in an attempt to reduce the on-site construction costs at the remote locations and thereby reduce the penalty for siting the PBSFSL at an isolated location. The major subsystems for each module will be considered and perhaps modularized to the point where only assembly is required. Modularization would also allow subsystem checkout in controlled environments to verify performance goals.

Schedule of Technical Activity During Project Formulation

Figure 4-9
4-22

These modularization concepts would eventually become part of the A&E bid package specifications.

c) Improved system level concepts:

The previous tasks developed improved modules which incorporated specialized construction and fabrication techniques. This task will develop improved systems concepts using the improved modules and subsystems. Further systems requirements analyses utilizing the new improved storage module sizes will be made to determine "final" facility quantities using the latest spent fuel profiles. Interfaces between modules as well as specific facility layouts will be developed. Facility descriptions for all the units will be made. Construction schedules for all the facilities will be made.

d) System level construction details:

Different methods and techniques for construction of the facilities require development and evaluation. Remote base cost factors are very high and methods which will allow cost reductions at a system level will be developed.

e) Regulating/licensing concepts:

The logistics of transporting and storing spent fuel will involve several nations and transport through international waters. All these entities have some regulatory criteria which must be satisfied when operating with nuclear material. These will be gathered up and a composite set of rules and governing regulations established.

The effects of these regulations on PBSFLS design will be evaluated. Technical concepts for meeting these regulations will be generated and candidates for further consideration will be recommended.

- f) Develop methods and techniques for licensing:
Different concepts for regulating and licensing the different PSFLS components were suggested in (e). The intent and purpose of this task will be to further evaluate the concepts and further expand and develop those candidate concepts and techniques. The results of this action will be a very specific licensing plan and set of regulations subject, to consortium approval and ratification.

- g) Cost estimation:
Item (a) will develop improved concepts to a greater depth than those established in the current GSFLS study. The costs for these improved modules must be estimated. This estimate will be used in a cost analysis for the system.

- h) Financial analyses:
The detailed cost estimates made in item (b) and the improved systems concepts and requirements of item (e) will form the basis for a more definitive financial evaluation. The financial analyses will be made from computer analyses using such inputs as debt/equity ratios, owner cost, tax rates, R.O.I.'s and bond interest.

The value of this analyses will be in the acquisition of funds from credit sources and in gaging the performance of subcontractors. The computer model will be revised to include the best available techniques for computation of pro-forma statements.

i) Preliminary site selection studies:

Technical site selection studies including an assessment of geologic; meteorological; demographic; resources availability; housing infrastructure; labor cost factors, etc. Will be evaluated. The purpose of this task will be to generate a set of selection criteria with the appropriate weighting functions to be used in determining site suitability. Many sites will be considered and evaluated using the criteria. Recommended or candidate sites will be selected for further consideration.

j) Final site selection:

This task is a continuation of (i) except that a specific PBSFSL site will be selected. Trips to review the site will be made for final assessments.

2. PBSFSL Technical Definition

The following tasks are those required to assemble an industry team and place them on contract for detail design and development.

a) Concept preliminary design:

The technical support tasks described above developed concepts and plans to accomplish the PBSFSL. This task will integrate the above results and present a fully unified plot plan and facility description for all facilities (including ancillary facilities). The results of this work will define A&E service requirements.

b) Detailed cost estimate:

Detailed costs estimates will be prepared for the concept preliminary design described in (a).

c) Construction schedules:

A detailed program construction schedule is necessary for the project. It would include major milestones that the contractors would be required to meet. This task would ultimately produce a complete set of schedules beginning with a top level tier and sequencing through, at least every major facility. This set of schedule would become one of the major performance evaluations for the selected contractor.

d) Technical specification - Design requirements:

This task will prepare a set of technical requirements and specifications for each facility. These specifications will include performance parameters, shielding requirements, cooling requirements and interface points.

e) Technical specification - Verification requirements:

This package or document will contain the test or verification requirements for all facilities and components. Quality assurance standards and test methods would be included (i.e., inspection requirements and record keeping for "N" stamp). These requirements would be considered in project pricing.

f) Safety plan:

The safety plan is the document which defines all safety criteria which must be met by the facility design or by procedure. Some of the safety criteria requirements headings are as follows: Radiological Safety, Mine Safety, Industrial Safety, Explosives Safety, Motor Vehicle and Traffic Safety, Transportation of Radioactive Material, Fire Protection, Industrial Hygiene, Environmental Sanitation, etc. These standards and criteria will have to be acceptable to the host country and will be subject to ratification by the consortium representatives. This plan will be an integral part of the instructions to the industry team.

g) Safeguards plan:

The Safeguards Plan will be a document which defines the criteria necessary to fully protect all Special Nuclear Materials (SNM) from theft or sabotage. The requirements for special in-plant detection systems for SNM will be expressly delineated as well as those for controlling personnel access and egress. The

requirements for remote sensing of intruders and the appropriate responses will be defined. All site boundaries and their fencing requirements will be specified. The criteria for walls and doors will be specified if they lead directly into a region or area where nuclear materials are stored. This plan will become a part of the instructions to the industry team.

h) Verification/licensing plan:

This plan will contain approved methods and test techniques to be used in testing components to ensure that they meet technical requirements. This plan will also contain the special inter-relationship and working plan by which the PBSPLS will be licensed. This document will contain the approved design and computational techniques or will describe how company proprietary methods are to be benchmarked to existing systems.

1.0 INTRODUCTION

The institutional aspects of a European spent fuel arrangement are significantly different from the Pacific Basin. In Europe, there are many differing national interests involved which rule out simple approaches. Commercial reprocessing is extant and expanding with as many as six nations having various degrees of commitment to the national reprocessing path. Permanent storage or disposal commitments are required as a vital link to AFR storage initiatives. European nations have differing reprocessing rationales, and the European breeder development program schedule is ahead of that of the Pacific Basin.

U.S. policy calls for the deferral of commercial reprocessing until a new international consensus is reached on technical and institutional measures which will allow energy recovery from spent fuel to go forward under acceptable nonproliferation conditions. In attempting to give maximum effect to this policy under the complex conditions prevailing in Europe, the study concludes that the most promising approach is to seek to bring existing reprocessing programs into a framework which results from mutually agreed upon - by the U.S. and the European countries - nonproliferation conditions which they would apply. The alternative to this might well be arrangements which lead to greater restrictions on the reprocessing of limited amounts of spent fuel, while allowing large amounts of fuel to be reprocessed under inadequate nonproliferation conditions. Thus, the recommended approach places greater emphasis on that aspect of U.S. policy which

calls for international agreement on improved nonproliferation conditions, both technical and institutional, and relatively less emphasis on deferral for deferral's sake alone.

The study addresses the spent fuel storage issue. The development of acceptable spent fuel arrangements in Europe requires, however, that permanent storage and reprocessing be considered at the outset. Spent fuel disposition alternatives could provide a basis to negotiate multinational nonproliferation arrangements with existing national reprocessing interests. These alternatives provide strengthened rationale to influence national reprocessors on nonproliferation criteria and at the same time offer nations served an acceptable spent fuel disposition service if needed.

As a result, two approaches can be envisioned for a nonproliferation arrangement. The first approach is to build exclusively on existing European and U.S. institutions, providing U.S. support and obtaining a mechanism for U.S. cooperation in European reprocessing criteria and decisions. The second approach would develop multinational spent fuel logistics operations in Europe which would offer storage and associated fuel cycle service reflecting nonproliferation concerns not accepted by existing reprocessing institutions. The second approach would come in place if the first could not be implemented.

The purpose of Part III is to review key considerations and conceptual options for a spent fuel logistics system serving the European region. The scope and organization of Part III is as follows:

Section 2 - Identification of Key Constraints and Objectives for Shaping a European Spent Fuel Arrangement.

Section 3 - Identification of Major Criteria

Section 4 - Formulation of a European Arrangement

Section 5 - Materials Accountability and Control Regime Considerations.

Section 6 - Preliminary Organizational Considerations

Section 7 - Technical/Financial Evaluation of a European Regional Spent Fuel Logistics System (ERSFLS).

2.0 IDENTIFICATION OF KEY CONSTRAINTS AND OBJECTIVES FOR SHAPING A EUROPEAN SPENT FUEL ARRANGEMENT

The GSFLS Institutional framework section developed for Europe (Part I, Section 2.2) indicates that in contrast to the Pacific Basin situation, no single nonproliferation consideration can provide a workable basis for developing an acceptable reprocessing deferral scenario. The principle consideration for implementing a Pacific Basin spent fuel arrangement was to provide a means of storing LWR spent fuel so as to reduce the pressure to prematurely reprocess as a means of spent fuel disposition. The reasons for responding to additional nonproliferation considerations for a European spent fuel arrangement are based on the following constraints:

- (1) From a spent fuel disposition standpoint, a multinational AFR storage initiative does not offer a viable alternative to early reprocessing if not linked to a permanent disposal scheme capable of handling the forecasted unreprocessed spent fuel flows.
- (2) Commercial LWR reprocessing is extant, and present capacity will eventually be expanded to accommodate near term international market needs.
- (3) Six European nations are on the critical path to any nonproliferation strategy: France, Germany, the U.K. and Belgium for the near term, and Spain and Italy for the intermediate term. All six

nations are, with various degrees of commitment, on the national reprocessing path.

- (4) European nations have distinct views about the residual energy value of spent fuel, and therefore have different reprocessing rationales.
- (5) The breeder development program appears successful, and FBRs could be ready for deployment in France, and Germany in the intermediate term.

In such a complex and non-homogeneous situation where most European nations have multi-faceted motivations and concerns, the identification of dominant national concerns become critical to the formulation of nonproliferation criteria and their supportive concept alternatives. Simply stated, when confronted with an offer, nations are generally willing to trade second order motivations for an acceptable solution to their dominant concern(s). To that extent, dominant national concerns constitute the critical core around which criteria and concept alternatives can be designed and tested.

Country groupings that solely reflect dominant national concerns over the back-end of the fuel cycle are therefore in order for Europe. Based on Figure 2-2 (Part I-Section 2.2) new country groupings based on national values placed on spent fuel and national reprocessing rationales can be identified by categorizing countries' dominant concerns. The country groupings include:

- (1) A Waste Management-Oriented Group: where the dominant concern is the definition of a safe and acceptable scheme for permanent disposal, reprocessing being a path to such an end. Second order motivations can include recovery of residual energy value from spent fuel. Characteristically, such nations attribute a negative (or zero) value to spent fuel, or are split (government vs. utilities) on the issue.
- (2) A National Reprocessing-Oriented Group: where the dominant concern is the recovery of the residual energy value from spent fuel, and/or the presumed commercial value of reprocessing per se. Second order motivations can include waste management and/or breeder deployment needs. Characteristically, such nations attribute a positive value to spent fuel both at the governmental and utility industry level.
- (3) A Breeder Deployment-Oriented Group: where the dominant concern is the timely production of Pu feed for the breeder. Second order motivations can include LWR recycle and/or waste management considerations. Characteristically, such nations are the key partners of the SERENA Agreement*, and have an extant (or will have a near term) commercial reprocessing capability.

* Countries involved in the SERENA Agreement include: France, FRG, Italy, Belgium and the Netherlands.

In assigning countries to the foregoing categories (see Figure 2-1), the following considerations should be recalled: (1) Waste Management-Oriented countries represent the most flexible group for accepting a nonproliferation arrangement in the region, (2) acceptance of a nonproliferation arrangement decreases significantly with group #2, and (3) a quasi-rigid situation is reached with the last group.

This receptivity assessment bears important implications for criteria and supportive concept alternatives formulation. First, for criteria formulation purposes, the nonproliferation considerations that could be attached to a European spent fuel facility should account for such a gradation in receptivity levels. With decreasing importance, the following considerations applicable to spent fuel facilities in Europe are:

- (1) Reduction of incentives for national fuel cycle activities, including national reprocessing.
- (2) Implementation of a bridge vehicle allowing for time to develop permanent disposal solutions and relieve pressure for premature fuel movements into reprocessing options.

Figure 2-1

DOMINANT NATIONAL CONCERNS AND RESULTING COUNTRY GROUPS,
MINIMUM OFFER, AND SPENT FUEL FLOW CONDITION

<u>CATEGORIES</u> <u>OF DOMINANT</u> <u>NAT'L CONCERNS</u>	<u>NATIONS/</u> <u>DOMINANT</u> <u>CONCERNS</u> <u>GROUPINGS</u>	<u>ATTITUDES</u> <u>TOWARD NAT'L</u> <u>REPROCESSING</u> <u>DEFERRAL</u>	<u>MINIMUM OFFER</u> <u>CONDITION</u> <u>FOR CONCEPT</u> <u>FORMATION</u>	<u>SPENT FUEL</u> <u>FLOW</u> <u>CONDITION</u>
WASTE MANAGEMENT - ORIENTED GROUP (Group #1)	Sweden Norway Finland Denmark Netherlands ¹ Switzerland Austria Luxemburg ²	More Cooperative Attitude	AFR Storage (Bridge) to Develop Permanent Storage Scheme ^{3/}	Permanent Spent Fuel Disposal Outside of Group #1 Countries
NAT'L REPROCESSING - ORIENTED GROUP (Group #2)	Italy ¹ Spain Belgium ¹ U.K.	Less Cooperative Attitude	Nonprolifera- tion Criteria For Conditional Reprocessing	Adequate Load Balancing for Reprocess- ing Activities
COMMERCIAL FBR - ORIENTED GROUP (Group #3)	FRG ^{1,2} France ¹			

1/ SERENA Agreement Signators

2/ Luxemburg will follow FRG's waste management options

3/ Does not preclude multinational reprocessing

- (3) Avoidance of unwanted technology transfers
- (4) Avoidance of nationalization of multinational spent fuel facilities by host country
- (5) Avoidance of possible deemphasis of proliferation concerns and safeguards
- (6) Avoidance of host country cessation or slowdown of fuel cycle functions.

Second, for the purpose of formulating supportive concept alternatives, the linkage and/or decoupling among the foregoing groups of countries bears important nonproliferation implications. Any linkage between two (or more) groups could bring the new, larger group to deemphasize nonproliferation concerns and safeguards. For instance, the nonproliferation concerns of the waste management-oriented group could be more easily satisfied with a reprocessing deferral than those of the group (2) (Figure 2-1).

Furthermore, any linkage and/or decoupling strategy should carefully examine the implications involved that could substantially limit the geographic base of a nonproliferation arrangement. Finally, it appears that no single concept is able to respond satisfactorily to the entire spectrum of

nonproliferation concerns unless it encompasses three basic functions: (1) an AFR capability allowing for the development of acceptable reprocessing criteria, (2) a deferred reprocessing capability, and (3) a permanent storage capability (Figure 2-1).

In summary, the delineation of key constraints and nonproliferation considerations in shaping a European spent fuel arrangement concludes that:

- (1) As the nonproliferation considerations are singled out for implementation, the geographic base of the nonproliferation arrangement could decrease significantly. Conversely, addressing all the nonproliferation considerations would involve the recognition of near term commercial reprocessing interests in Europe.
- (2) Nonproliferation considerations cannot be addressed if concepts for European arrangements do not center on the reprocessing and permanent disposal issue at the outset. Only then, can an AFR capability be accepted as a means to reduce the pressure to prematurely reprocess as a means of spent fuel disposition.
- (3) The recognition of near term commercial reprocessing interests in Europe would recommend building a nonproliferation arrangement on existing institutions first. This approach failing, recourse to

developing new institutions would then be warranted.

The foregoing conclusions constitute the background against which the nonproliferation, business operations and financial strategy criteria, the control regime and organizational considerations will be developed for European spent fuel disposition arrangements.

3.0 IDENTIFICATION OF MAJOR CRITERIA

The formulation of an arrangement in Europe requires the development of criteria that would both characterize the working environment of such an arrangement and provide the necessary guidelines for designing alternatives. Three sets of criteria define the successful implementation and operation of a European arrangement: (1) nonproliferation criteria, (2) business operations criteria, and (3) financial strategy criteria. Consistent with the conclusions of the previous section, the definition of criteria differentiate those applicable to existing institutions from those applicable to new institutions as the need for the latter category is recognized.

3.1 IDENTIFICATION OF NONPROLIFERATION CRITERIA

3.1.1 Nonproliferation Criteria Applicable to Existing Institutions

Nonproliferation Criteria applicable to existing institutions include:

- (1) The definition of conditional reprocessing criteria, including reprocessing deferral, focusing on energy conservation and waste management considerations, and the adequate development of proliferation resistant techniques and institutions.

This criteria definition will help influence extant reprocessing interests in Europe and permit the development of more proliferation resistant techniques and institutions.

- (2) The U.S. commitment to use the MB-10 procedure to foster the adoption of multinational controls by the reprocessing nations.
- (3) The U.S. commitment to provide adequate incentives (technology transfers, stability guarantees, permanent storage alternatives) to the reprocessing countries not affected by the MB-10 procedure (F.R.G. and Belgium), but willing to accept multinational controls.

This commitment will clearly demonstrate the U.S. willingness to cooperate in the field of multinational controls.

- (4) The preference for a single, multinational control regime rather than several regimes controlling European arrangements.

This preference will indicate the U.S. commitment to achieve as simple and efficient nonproliferation arrangements as possible.

- (5) The U.S. commitment to permanently store spent fuel of those nations deliberately selecting the once-through alternative.

- (6) The U.S. commitment to provide a backup permanent storage alternative for the HLW of the appropriately conditioned reprocessors which accept multinational controls and do not possess permanent solutions.

This commitment will permit a stronger basis for cooperation on the part of some of the reprocessing nations.

- (7) The U.S. assurance that agreed upon flexibility in spent fuel release will be provided under the arrangement for those countries that choose to store their spent fuel in multinational AFRs.

This assurance will allow a maximum of countries to join a nonproliferation arrangement in Europe.

3.1.2 Additional Nonproliferation Criteria Applicable to New Institutions

Two situations could lead to the planning of new institutions: First, the AFR and permanent storage capability of the existing institutional fabric cannot accommodate the storage requirements. Second, reprocessing nations may not be responsive to nonproliferation arrangements. In such situations the additional nonproliferation criteria applicable to new institutions include:

- (1) The strong U.S. commitment to support multinational center(s) in Europe to handle the back-end of the fuel cycle, should (1) discontinuities in the logistics systems develop, or (2) the reprocessing nations not respond.

This commitment will show the U.S. decision to develop alternatives in cooperation with the URG* countries, expecting in return, their acceptance of multinational controls.

- (2) The U.S. commitment to support multinational center(s) for handling the back-end of the fuel cycle as/if needed, as opposed to nationally operated centers with multinational controls.

This commitment will demonstrate the U.S. determination to avoid at all costs the development of new national reprocessing plans in Europe.

*United Reprocessing group countries include France, United Kingdom (U.K.) and the Federal Republic of Germany, (FRG).

- (3) The U.S. decision to accept the siting of multi-national center(s) in nations having signed and ratified the NPT treaty only.
- (4) The decoupling of spent fuel storage from other possible nuclear fuel cycle options in the multi-national center(s) until reprocessing criteria are met.

This decoupling will ensure that a means of storing LWR spent fuel will be found rapidly so as to reduce the pressure to reprocess as a means of spent fuel disposition.

- (5) The U.S. assurance that none of the other possible nuclear fuel options will be foreclosed for the multinational center(s) at any time in the future.

This assurance will allow the participation of those countries planning for national reprocessing.

3.2 IDENTIFICATION OF BUSINESS OPERATIONS CRITERIA

3.2.1 Business Operations Criteria Applicable to Existing Institutions

- (1) The clear distinction between national and multinational levels for delineating the scope of and structuring the European arrangement.

This distinction will allow complete freedom for the parties to structure their own national participation ownership interface as they deem it desirable, while allowing for the leadership of a few nations at the multinational level.

- (2) The clear distinction between business/regulatory and nonproliferation control functions to support the performance of national business/regulatory responsibilities, and the performance of multinational nonproliferation control responsibilities.

In the event of reprocessing, this distinction will allow operational capability and regulatory effectiveness for the business entities as the reprocessing nations would see fit, while giving the nonproliferation controls to the responsible multinational entities.

- (3) The U.S. assurance that it would be responsive to the URG* arrangement in shaping European spent fuel arrangements.

- (4) The mutual (U.S./European) understanding that the U.S. would directly offer its services to countries desiring to store permanently their spent fuel only.
- (5) The U.S. assurance that the U.S. AFR, permanent (HLW) storage, and reprocessing capability would support the extant European system if/as the need is recognized by the multinational participants.

This assurance would further enhance the U.S. determination to develop cooperative relationships with URG countries, assuming that the latter would accept European nonproliferation arrangements.

3.2.2 Additional Business Operations Criteria Applicable to New Institutions

Should discontinuities in the logistics systems develop, or reprocessing nations not be responsive to nonproliferation arrangements, additional business operations criteria would include the following:

- (1) The U.S. commitment to provide managerial, and technical support to multinational center(s) eliminating discontinuities in the extant logistics systems.
- (2) The definite U.S. commitment to develop and implement joint business strategies with cooperating nations and allocate all its logistical capability in this endeavor, including fuel feed support.
- (3) The agreement to launch (as/if needed) private, multinational center(s) open to public sector participation at the discretion of the national parties.

This business arrangement will satisfy all prospective European partners, while giving each government the option to participate at its perceived most appropriate level, and independently.

- (4) The clear distinction between national and multinational levels for structuring the participation and ownership arrangements of the multinational center(s).

This distinction will permit maximum flexibility in developing participation strategies in multinational centers.

- (5) The clear distinction between the business operations functions and the regulatory/control functions in the multinational center(s).

This distinction will ensure adequate operational capability for the business entities to complete their functions in a commercial context and act as cost minimizers, while giving the nonproliferation and safety controls to the responsible public entities.

- (6) The preference for a multinational AFR concept as an appropriate startup nucleus for further fuel cycle activities in the multinational center(s).

This preference for an AFR startup will solve Europe's most urgent need for storage space, while (1) ensuring European nations that other activities will clearly be under consideration, and (2) testing the concept with one of the most simple activities in the back-end of the fuel cycle.

3.3 IDENTIFICATION OF FINANCIAL STRATEGY CRITERIA

Should discontinuities in the European logistics systems develop, or reprocessing nations not respond to nonproliferation arrangements, a U.S. financial involvement could be required. In such cases, the proposed financial strategy criteria include:

- (1) The U.S. decision to support financing one multi-national center if discontinuities and/or lack of response from the reprocessors occur.

The decision to support financing of only one center would demonstrate the preeminence of nonproliferation considerations in U.S. financing strategy.

- (2) The U.S. preference to support financing a multi-national center offering a permanent storage solution over alternatives not offering such a capability.

This preference will further exemplify the U.S. commitment to minimize proliferation and diversion risks and to provide incentives to those nations accepting/proposing permanent storage plans.

- (3) The decision to allow maximum flexibility between equity financing and loans/bonds availability in shaping governmental participation.

The use of government guaranteed loans or bonds (payable after the AFR facility begins to earn sizeable profits, for instance) would reduce the need for initial owner equity commitment while providing (1) a reasonable cost of services to the utilities, and (2) a good leverage effect for the owner/investor's ROE in the venture.

- (4) The agreement to tailor-fit governmental incentives to help management maintain competitive storage only services for both the users and the owners if/when reprocessing activities are launched.

Such an agreement will ensure governmental support for maintenance of storage only services over the long term.

- (5) Governmental commitments, after the launching decision has been made, to find at an early date a location for the multinational center that would be acceptable to all the parties.

To the extent that the location of the AFR facility could significantly impact on the costs of the enterprise (i.e., distance of transportation, additional logistical requirements, and alternative storage concepts), the early indication of an agreeable site should be assured.

- (6) Governmental commitment to settle early on durable regulatory requirements for the multinational center.

To the extent that the regulatory framework could significantly impact on the profitability of the enterprise, an early agreement on regulatory standards should be arranged with the assurance that it would represent a reasonably stable framework for the life of the project.

4.0 FORMULATION OF A EUROPEAN ARRANGEMENT

The study addresses the spent fuel storage issue. The development of acceptable spent fuel arrangements in Europe requires, however, that permanent storage and reprocessing be considered at the outset. Spent fuel disposition alternatives could provide a basis to negotiate multinational nonproliferation arrangements with existing national reprocessing interests. These alternatives provide strengthened rationale to influence national reprocessors on nonproliferation criteria and at the same time offer nations served an acceptable spent fuel disposition service if needed.

As a result, two approaches can be envisioned for a non-proliferation arrangement. The first approach is to build exclusively on existing European and U.S. institutions, providing U.S. support and obtaining a mechanism for U.S. cooperation in European reprocessing criteria and decisions. The second approach would develop multinational spent fuel logistics operations in Europe which would offer storage and associated fuel cycle service reflecting nonproliferation concerns not accepted by existing reprocessing institutions. The second approach would come in place if the first could not be implemented. The outline of the two approaches follows:

4.1 APPROACH #1: BUILDING ON EXISTING INSTITUTIONS

The assumption in this approach is the recognition of the present URG organization, capabilities and contracts. The principle elements of this approach are as follows:

- (1) A mechanism would be established, such as a "General Council" organization, to develop and implement non-proliferation policy regarding spent fuel interim storage, reprocessing and permanent storage, and Pu utilization. The nonproliferation policy would include criteria for a spent fuel release mechanism covering energy resource conservation requirements and appropriate technical and institutional matters related to the release mechanism. The timing and the technical and institutional factors associated with reprocessing and Pu utilization would be defined. The criteria for extending technology transfer in sensitive areas would be defined. The membership of the General Council would include government representatives of the U.S., U.K., France, F.R.G., Belgium, and countries offering permanent storage alternatives. The nonproliferation policy and practices established would have to be acceptable to all founders.

- (2) The U.S. would allow business as usual conditions to prevail for the URG and Belgian reprocessing. However, such operations would proceed under the nonproliferation policies of the General Council. DNFL and COGEMA would perform load balancing between them as they see fit. Belgium could integrate into the URG structure. F.R.G. could service Austria and Luxembourg as they see fit.
- (3) The U.S. would provide a back-up for permanent storage. European reprocessing countries would make best efforts to develop permanent storage. The U.S. would directly offer permanent storage to those countries not committed to reprocessing.
- (4) Barnwell would be offered as a back-up reprocessor if required by the European and U.S. markets. This could be done as an extension of the URG structure, appropriately enhanced.
- (5) Expansion of European fuel cycle centers would be supported as approved by the General Council. The General Council would be expanded to include government representatives of additional fuel cycle center countries. The U.S. would provide initiatives if appropriate to develop an additional multinational fuel cycle center serving Mediterranean countries. In effect, this operation would organize as an extension of the URG structure.

- (6) The approach recognizes the possibility of a Swedish AFR, however, the assumption is that the Nordic fuel would go to BNFL.COGEA.

4.2 ALTERNATE APPROACH #2: DEVELOP NEW INSTITUTIONS

In the event that the approach #1 is unsuccessful, the assumption is that the U.S. would act to stimulate multinational centers which would offer European spent fuel disposition services. The reference case assumes most nations, except URG countries, would be responsive to a European arrangement and work toward a single fuel center in the Mediterranean. There are two modifications, one in which the Northern Europe countries separate from the Mediterranean Center and one in which the Mediterranean Center does not develop and fuel flows to centers in either Sweden or Belgium and the U.S.

Reference Case

- (1) Japanese fuel is positioned for the Pacific Basin consortium.
- (2) The U.S. stimulates the interest for a Mediterranean center to serve as a fuel center host for the non-URG European countries, including Belgium. The Mediterranean center offers to provide permanent storage services associated with the fuel center in return for financial support from European countries. A mechanism would be established such as a "Commission" to develop and implement

nonproliferation policy regarding spent fuel interim storage, reprocessing and permanent storage, and Pu utilization. The nonproliferation policy would include criteria for a spent fuel release mechanism covering energy resource conservation requirements and appropriate technical and institutional matters related to the release mechanism. The timing and the technical and institutional factors associated with reprocessing and Pu utilization would be defined. The criteria for extending technology transfer in sensitive areas would be defined. The non-proliferation policy and practices established would have to be acceptable to all founders.

- (3) The financial participation would include the U.S. and the European countries being served.
- (4) The U.S. would provide a back-up for permanent storage. The Mediterranean center would make its best efforts to develop permanent storage. The U.S. would directly offer permanent storage to those countries not committed to reprocessing.
- (5) Barnwell would be offered as a back-up reprocessor if required by the European and U.S. markets.

- (6) The approach would recognize the possibilities of Belgian reprocessing and of a Swedish AFR; however, the assumption of the reference case is that neither would operate and that no additional European centers would be newly developed.

Modification #1, Northern Countries Separate from Mediterranean Center

- (1) In the event that the sense of this approach is accepted by the non-URG European countries, but that the Northern countries prefer to limit their involvement in a Mediterranean Center, the reference case is modified to include a Northern Europe Fuel Center located in either Sweden or Belgium. The Nordic Council countries plus Netherlands and Belgium would send their spent fuel to that center. The Mediterranean Center would serve Switzerland, Austria, Italy and Spain.
- (2) The Commission of the reference case would extend separately or as a joint function of the Northern Europe and the Mediterranean centers, the joint function being preferred.
- (3) The Mediterranean center would offer and make best efforts for perma-

ment storage services to both centers. The U.S. would provide a back-up for permanent storage and directly offer permanent storage to those countries not committed to reprocessing.

- (4) Financial participation in the Mediterranean center would include the U.S. and the countries served. In addition, the northern countries would compensate the Mediterranean center for permanent storage services only.
- (5) Financial participation for the Northern Europe Center would include the countries served and not the U.S.
- (6) The Belgian reprocessing center would not operate if Sweden were the Northern Europe host nation and there would be no additional European centers newly developed.
- (7) Barnwell would be offered as a back-up reprocessor if required by the European and U.S. markets.

Other elements as in the Reference Case.

Modification #2, Mediterranean No-Go

- (1) In the event that the sense of this approach is accepted by the non-URG European countries, but that the

Mediterranean center is not a possibility, the Northern Europe center as identified in Modification #1 is expanded to include Switzerland and Austria. The Mediterranean Center countries of Modification #1, less Switzerland and Austria, form a multinational arrangement with the U.S. as host country.

- (2) In this modification, the U.S. would support the Northern Europe center financially.
- (3) The U.S. host country center would be financed by the U.S. and the countries served.
- (4) The Northern Europe center host country would make best efforts to accommodate permanent storage.

Other elements as in Modification #1.

5.0 MATERIALS ACCOUNTABILITY AND CONTROL REGIME CONSIDERATIONS

5.1 GENERAL CONSIDERATIONS

A general treatise on the subject is included in Volume 1, Appendix B. In this section the materials accountability and control regime considerations are first summarized and then particularized as related to the two forms of proposed U.S. initiatives for Europe.

- (a) In this initiative, the U.S. would continue to recognize the primacy of the IAEA's role in the application of safeguards, reflecting the conclusion that only an organization of global composition can provide universally credible assurances that diversion is not taking place.
- (b) The owners and operators of nuclear facilities or holders of nuclear material, as well as their national authorities, and, by extension, any regional authorities created also have legitimate interests in the control of nuclear materials under their supervision or jurisdiction.
- (c) Verification activities of each organization tier, no matter how technically effective, cannot provide a credible substitute for, and should not be interposed as a limiting factor upon, the verification activities deemed necessary by each higher tier of authority to meet its responsibilities for independent verification.

- (d) Independent verification is the essential principle of a meaningful verification system; however, full use of the data secured by lower tiers is desirable, particularly to be cost effective.
- (e) Verification must be complemented by appropriate measures for physical protection of nuclear material from subnational threats including diversion, seizure and sabotage. The IAEA has no authority to apply such measures to national or regional facilities.
- (f) The current nonproliferation regime contains no provision for physical protection against national threats, relying instead on the detection of such acts by the safeguards system and on the penalties which might flow from such detection.
- (g) Even though the IAEA is authorized to acquire and operate facilities on its own behalf under certain circumstances, such as spent fuel storage, the Agency has never exercised, or sought to exercise, this authority.
- (h) Similarly, no regional or multilateral authority has yet taken primary responsibility for physical protection of materials, although multilateral organizations such as the former EUROCHEMIC have assumed on-site responsibilities. So as to preclude the

multinational organization from the sensitive position of having to use force against host country nations, it would appear prudent to have the physical protection at and beyond the plant boundary be assigned to the host country.

- (i) National policies, including that of the U.S., on the proper allocation of either verification or physical protection responsibilities have not, insofar as the Study is aware, been established. Similarly, there is little background and experience concerning the response to violations or abrogations of nonproliferation undertakings.
- (j) Most proposed combinations of participants include EURATOM and non-EURATOM countries. It is noted that while EURATOM Member States were and presumably are satisfied with the reliance on the objectivity of their safeguards measures, the Soviet Union has expressed a reluctance to accept EURATOM inspection as a credible assurance against diversion.
- (k) While a multinational consortium has an important verification role, this role should not diminish the rights and responsibilities of the IAEA to verify the findings of the multinational system.
- (l) The formation of the release criteria and mechanisms is among the most difficult of the nonproliferation

programs in a multinational concept. One approach would be to adopt a requirement for unanimity of the release of the material, in effect leaving for future determination the criteria that would guide release. Alternatively, a variety of voting formations could be devised which would preclude release at sole discretion of the depositor, but which would also fall short of a veto power by each participant implicit in a requirement for unanimity. In any case, the absence of some definition of the release criteria could dampen the willingness of countries to participate because of uncertainty as to whether and how the energy value of the deposited fuel might be recovered.

Another approach, therefore, is to seek to prescribe in the initial agreement the criteria which will govern release. For example, the criteria might include some evidence of international consensus on the back-end of the fuel cycle, coupled with a need by the depositor for the material.

The release issue is closely related to the issue of expansion of activities, such as interim storage, to other fuel cycle activities. At the onset of a storage scenario, it may be difficult to foresee the circumstances which would prevail if and when the scope of its activities are enlarged. Never-

theless, it is important to be agreed on the principles - both substantive and procedural - to be applied to any proposed expansion.

5.2 APPLICATION TO APPROACH #1, BUILDING ON EXISTING INSTITUTIONS

The emphasis in applying materials accountability and control regime considerations to existing service organizations, such as BNFL and COGEMA, should be in the development and implementation of release criteria and mechanisms. It is assumed that the principals in determining the release criteria and mechanisms are the fuel service nations and the U.S. In developing the balance of the considerations, maximum use would be made of existing organizations and arrangements, where possible.

In applying these considerations to newly developed organizations, such as Mediterranean or Northern European fuel service centers, the emphasis should be in fully developing a materials accountability and control regime which involved as participants fuel service countries, the larger users and the U.S. in the organization to establish and implement criteria.

5.3 APPLICATION TO APPROACH #2, DEVELOP NEW INSTITUTIONS

In this approach, all organizations dealt with are newly developed. Emphasis should be in fully developing a materials accountability and control regime which involved as participants

fuel service countries, the larger users and the U.S. in the organization to establish and implement criteria.

The release criteria and mechanisms associated with this approach probably would not represent a consensus position with existing European institutions. The arrangements associated with this approach most likely would have more deliberate considerations and stringent requirements associated with reprocessing decisions.

6.0 PRELIMINARY ORGANIZATIONAL CONSIDERATIONS

The purpose of the following sections is to scan possible implementation/formation alternatives supportive of the approaches identified in Section 4, and compatible with Section 5 considerations.

6.1 APPROACH #1: BUILDING ON EXISTING INSTITUTIONS

In light of the nonproliferation, business operations, and financial strategy criteria, as well as the control regime considerations, additional organizational developments should be avoided to the extent possible since the thrust of the Approach #1 is to build on existing institutions.

The most important simplifying factor in the Approach #1 is the practical elimination of a business and/or enterprise component(s) from the postulated arrangement, at least in its initial stage. In Approach #1, the initiative basically centers on appropriate multinational controls since no competition is sought against the reprocessing nations. Considering that possible business-related developments are secondary in nature in Approach #1, no treatment of this subject will be provided in this section, but will be presented in the following section where the aspects of launching an enterprise will be treated.

Three qualifying comments are in order for the Approach #1. First, the U.S. would offer permanent spent fuel storage for those nations deliberately selecting the once-

through alternative. This service would not compete with the reprocessors' capabilities and would probably involve the smaller countries only (i.e., the Netherlands, Denmark, Austria) which are not critical to the load balancing of Europe's spent fuel. At any rate, this permanent storage activity would not require any particular organizational development on Europe's part.

Second, an additional AFR capability is needed to service Italy and Spain which have terminated their contracts with the URG countries. The launching of an additional AFR capability to service those two countries should not impact the business planning of the URG system, and would not involve the URG countries.

Third, to the extent that no multinational permanent storage solution is available in Europe today, and that a few European nations outside Belgium and the URG countries have definite plans for national reprocessing, the launching of an additional center could appear desirable in the future. The rationale for this new center would be to (1) offer a permanent storage capability in Europe, and (2) provide a multinational reprocessing capability that would eliminate the need for additional national operations.

Such a multinational center could, however, affect the prospective load balancing of the extant and planned URG reprocessing capability in Europe. Since the consolidation of existing centers is the major thrust of the Approach #1

the launching of an additional reprocessing center should be conditional. One of such conditions would be that the URG reprocessors would make their best efforts with U.S. support to encompass the entire European market, including Italy and Spain. Another possible condition would be that none of the URG reprocessors could offer a viable multinational permanent storage alternative. In the event that the Italian or Spanish markets could not be serviced by the URG capability, nor the latter provide a permanent storage solution, the launching of a new reprocessing center would then represent a logical course of action. To compensate for the loss of the Mediterranean market, the URG countries could be assured, through U.S. cooperation, of the consummation of the existing Japanese spent fuel contracts. In any event, such an agreement would not require major organizational involvements on the part of the URG countries.

With the three foregoing provisions addressing conditional business and market considerations, Approach #1 centers on the implementation of an appropriate multinational control regime. Since the cooperation with URG countries is sought, the participation structure, the scope and timeframe of the arrangement and the appropriate vehicle and mechanisms for implementation should be identified accordingly. These aspects are discussed in order.

Participation in the postulated arrangement should be primarily centered on the reprocessing countries in Europe (i.e., URG countries and Belgium) and the U.S. if the enhancement of existing institutions is sought. Most of the European nations would not therefore be invited to the arrangement, but would remain the customers of the URG countries.

The scope and timeframe for the multinational controls arrangement are clearly the most critical aspects of the Approach #1. On the premises that the present arrangement would be developed on a cooperative mode,

the U.S. should recognize, bona fide, existing verification and physical security procedures, results, and enforcement policies, and limit the scope of the arrangement to key nonproliferation considerations not addressed by existing European institutions.

Key considerations would be to:

- o Influence planned European reprocessing facilities to agree upon technical and institutional nonproliferation criteria prior to the initiation of reprocessing;
- o Define a joint U.S./URG/Belgian technology transfer policy for expanding URG's reprocessing capability;
- o Identify the conditions under which the launching of an additional reprocessing capability will be advisable and accepted;

- o Specify the control functions that the URG countries, Belgium, and the U.S. would have over the postulated multinational reprocessing center.

Timeframe definition should respond to two types of considerations. First, the time period should at least cover the years that are critical to the development of proliferation resistant reprocessing alternatives. Second, the timeframe, however, cannot be stretched too far so as to turn away the URG countries from the agreement. The proposed timeframe is therefore a 10 year period (1980-1990), with the understanding that the agreement could be renewed.

The appropriate vehicle and mechanisms for implementation should be careful to recognize, and avoid any overlapping with the existing European (EURATOM) and international (IAEA) institutional fabric. They should, however, ensure effective implementation of nonproliferation considerations in Europe. The most straight forward approach would include the development of a Memorandum of Understanding (MOU), and then the signature and ratification of a treaty covering (1) reprocessing conditions between the U.S., the URG countries and Belgium, and (2) reprocessing criteria for multinational center(s) that could be launched in the future. To ensure adequate control over time, a permanent body, such as a General Council, could be created by the Treaty. This General Council would include the Parties of the Treaty.

6.2 THE LAUNCHING OF A MULTINATIONAL CENTER OR OF A EUROPEAN REGIONAL ENTERPRISE INCLUDING SEVERAL CENTERS

Considering the nonproliferation, business operations and financial strategy criteria, as well as control regime considerations, both Approaches #1 and 2 call for the formation of a multinational center. It might therefore be appropriate to identify an organizational formation approach that could accommodate to most context situations (i.e., Approaches #1 and 2) to both ensure a smooth transition from one mode to the other, and capitalize on the experience gained during the initial phase of the process. Despite the fact that the multinational center would have distinct missions under the Approach #1 or the Approach #2, the concept and organizational approach could remain similar to maximize efficiency.

6.2.1 A Multinational Center Building on Existing Institutions - Evolved Through Approach #1

The basis for a multinational center under the Approach #1 would be to complement in two ways the extant URG system and provide (1) an additional AFR capability to service Italy and Spain which have terminated their contracts with COGEMA and BNFL, and (2) a permanent storage capability for spent fuel and/or HLW which is not currently available in Europe. The deferred reprocessing capability would be accepted

in exchange for the abrogation of additional national reprocessing plans in Italy and Spain. While the need for an AFR capability is urgent, the development of a permanent storage capability, once assured, is not as critical and could start operating in the 1990-1995 horizon. The deferred reprocessing operations could start in the same time frame.

Building on existing institutions, the organizational approach would be to start with the existing URG business policy arrangement and create a Reprocessing Business Coordination (RBC) function. The RBC function would be an extension of the existing URG framework including the U.S., Belgium and possibly the multinational reprocessing center (if/as launched). Underlying the creation of the RBC function would be a general agreement among the participating nations to assure adequate market sharing and load balancing between the national centers and the multinational center. Timewise, the creation of the RBC function would not be needed before the startup of the additional reprocessing capability.

In addition to its simplicity, the foregoing organizational approach could present several advantages that deserve consideration. First, it would demonstrate that the U.S. desire to cooperate with the existing institutional fabric in Europe is real and unambiguous. The initiative to locate the

headquarters in France or the U.K. would enhance the credibility of such U.S. cooperative efforts. Second, the U.S. would clearly demonstrate their willingness to put its reprocessing capability under the aegis of a multinational concept. Third, while it may not be appropriate to launch an RBC function in the near term, the pertinence of such an approach could strengthen over time as/if appropriate working conditions were to develop under the multinational Nonproliferation Treaty. The appropriate timing could be the renewal of the Nonproliferation Treaty (1990), when the need for a multinational reprocessing center could possibly emerge as a preferred solution. Fourth, URG investment in the multinational reprocessing venture would remain open, and would be left to the URG countries' entire discretion. Finally, all the extant national facilities (i.e., COGEMA, BNFL, Belgoprocess and Barnwell) could remain under national laws and ownership, while the RBC function would permit the launching of a deferred, multinational reprocessing center in a timely fashion, and under acceptable conditions for all parties.

6.2.2 A European Regional Enterprise (Including Several Centers) Involving New Institutions - Evolved through Approach #2

The basis for a European regional enterprise under the Approach #2 would be to offer nuclear fuel services under compatible nonproliferation requirements and provide (1) an AFR capability to service Northern European countries, Italy and Spain (Reference Case) or some other combinations (Modification #1 and 2); (2) a

permanent storage capability for Northern European countries, as well as Italy and Spain (for all cases); and (3) a deferred reprocessing capability to service all Northern European countries, Italy and Spain (Reference Case) or other combinations of countries (Modification #1 and 2).

As in the Approach #1, the need for an AFR capability is urgent, and should be launched at the earliest possible time, while the development of a permanent storage capability, once assured, is not as critical, and could start in the 1990-1995 horizon. Deferred reprocessing operations could start in the same time frame.

This organizational approach would require the development of a Convention aimed at resolving the problems of spent fuel storage in Europe. The Convention would focus on immediate AFR storage needs, and would guarantee the development of an acceptable permanent disposal alternative. Multinational reprocessing would be acknowledged as a viable alternative, and would be recognized as the preferred solution by the signators of the Convention.

The Convention would create two specialized institutions. First, a Commission composed of the government representatives of the sponsoring nations would be created to implement the

nonproliferation dispositions of the Convention. Among other responsibilities, the Commission would determine the number, the start-up schedule, and specific control regimes for the multinational reprocessing center(s) to be launched in the future.

The second organization created by the Convention would be a European regional enterprise. The first objective of the enterprise would be to satisfy the near and intermediate term AFR storage requirements of the Parties at the Convention until permanent storage alternatives are finalized. The enterprise could have several centers to allow, for instance, the launching of a Northern Europe AFR, if felt desirable by the Scandinavian countries. Diversification of the enterprise would be recognized and would specifically include permanent storage and reprocessing activities in the future.

At this stage, the Convention would constitute an organization nucleus (the Commission and the European Regional enterprise) around which further organizational developments could grow in the future. The intent is to start with a specialized (i.e., narrowly focused) enterprise providing the most simple possible services in the backend of the fuel cycle. Considering the capital intensiveness of the

AFR activity, and the market base for AFR storage services in Europe, the financing of the enterprise could be provided by the participating nations on a storage fee basis only. In order to meet financing requirements, the contracting could provide for completion and operation of project commitments, and to satisfy credit worthiness criteria, the contracting could also be based on governmental guarantees. Nominal equity financing participation from the sponsoring nations would be necessary to preserve the multinational character of the enterprise.

A restricted scope of activities would also ease the Commission's tasks during the start-up phase of the Convention, and would probably limit the surveillance and control staffing requirements at the early stages of implementation. During this period, the U.S. Barnwell facility would be used as a backup AFR capability alleviating some of the logistics problems involved with the launching of the European regional enterprise.

The second phase of the organizational development process (around 1990) would involve the diversification of the enterprise to include permanent storage and reprocessing activities. As a result, additional financing mechanisms and nonproliferation capabilities would have to be developed. In addition, coordination requirements

would also become evident as the number of existing and planned facilities would increase. Assuming that a complex situation would prevail, four centers could be envisioned. These would be as follows: (1) the Barnwell facility linked with other U.S. operations, (2) a Mediterranean multinational center, (3) and/or a possible Swedish or Belgium-based multinational center, and (4) and/or possibly two additional multinational centers (i.e., Swedish and Belgium) if the two countries do not desire to consolidate their activities into one center.

Two basic formation approaches are available for the diversification process and the resulting need for coordination. The first formation approach is to rely on contractual mechanisms to achieve adequate planning and load balancing between the (newly) diversified centers. Organizational developments would be kept at a minimum, and the existing institutions would take part in the contractual process as basically independent centers, with little, if any, intervention of a higher coordinating entity. Depending on the level of complexity of the contractual process, this approach is particularly efficient when a few centers are involved. Typically the JRG countries are organized according to this scheme, and re-

present a case where the number of parties is limited to three, and the arrangement is scoped down to a market sharing agreement only.

The best situation for this approach would be the Approach #2, Reference Case where only two centers would be existing (i.e., the Mediterranean center, and the Barnwell facility). The Approach #2, Modification #1 situation would be less favorable since three centers would be existing (i.e., the Mediterranean center, the Swedish or Belgium center, and the Barnwell facility). With the existence of four centers, the contractual formation approach would lose in contracting complexity what it hoped to gain in organizational simplicity. Figure 6-1 sketches the contractual formation approach under a complex situation.

With such an approach, the Commission would interface with each of the centers as separate entities, although some integration would be achieved at the European Regional enterprise level, and the centers constituting the enterprise (Figure 6-1). The financing of the U.S.-sponsored center would depend on the diversification pattern, and the number of affiliated center(s), and would range from the easiest situation (Approach #2, Reference Case) to a more difficult one involving several (diversified) center(s) (Modification #1-type situation). Under the Reference Case, the sponsoring nations of the Convention would consolidate their equity financing positions in the enterprise to allow for its diversification in permanent storage

Figure 6-1

CONTRACTUAL FORMATION APPROACH

and reprocessing activities. Cash flows generated by the mature AFR activity would provide an additional financial backup. More complex situations would probably require greater U.S. financing involvement.

The second formation approach shifts emphasis from contractual mechanisms to an integrated formation orientation. This approach becomes increasingly pertinent as the number of centers increases, and the business operations diversify over time. Figure 6-2 outlines the integrated formation approach under the complex conditions (i.e., 4 centers existing). Under this approach, the launching of a parent concept is sought for the coordination of existing and planned capabilities. As a result, the Commission would interface with the parent concept for policy decision matters, pursuing its audit and control functions at the center level (Figure 6-2).

Several formation alternatives for the parent concept are possible. One of the most widely used is the holding formation approach. The basic characteristics of this formation approach will be briefly explored since holding companies in general, but with government shareholdings in particular, are commonplace in Europe.

The holding parent could be financed by capital contributions of the sponsoring nations represented by the existing national (i.e., Barnwell, Belgoprocess), and multinational centers. A possible financing strategy would be to accept that

Figure: 6-2

INTEGRATED ORGANIZATIONAL FORMATION APPROACH

a fraction of the national centers, and all the multinational centers be transferred as capital contributions to the holding parent. The condition should be that each national plant be licensed for operation by an authority of the country of location, and that each multinational plant be licensed for operation by an authority of the host country under the supervision of the Commission.

In this fashion, the actual plant operation of existing facilities would be carried out by national entities fully subject to the laws of its country. Special regime(s) would apply to the multinational center(s) only. Common policies and control disciplines would be achieved through the holding parent of which all the voting stock would be owned by the respective sponsoring nations on the basis of their choice, i.e., on a private, public, or private-public hybrid mode. The parent ownership options described above would give the parent the ability to raise additional capital by issue of debt securities secured by the plant properties. Earnings generated by the parent ownership options would ultimately be channeled back to the sponsoring nations (after service of any debt) by reason of their holdings of parent stock.

Such a financing scheme would both significantly increase the debt financing capability of the centers (i.e., the bonds and/or loans being issued by the holding parent) and provide an opportunity for the U.S. to participate in the parent company with the Barnwell facility being a possible capital contribution.

Second, the creation of a holding parent would both allow Eurobond and U.S.-bond financing.

In summary, it should be pointed out that the foregoing approaches are not mutually exclusive. It appears that under the conditions defined by the Approach #2, a timely sequencing of the two approaches could be most appropriate and effective; that is, starting with the contractual formation approach, and developing into the integrated formation mode as warranted by the evolving situation. The logic of the formation options for such a development is presented in Figure 6-3.

In addition, both formation approaches would ensure a smooth transition, between phase I and phase II requirements as well as from one negotiating situation (Approach #1 initiative) to the other negotiating mode (Approach #2 initiative). The critical factor for capitalizing on experience as the organizational process develops is to maintain national ownership under multinational controls, and limit capital contributions to a fraction of the value of the national facility in the integrated approach supporting the launching of a multinational holding parent.

Figure 6-3
FORMATION OPTIONS
FOR THE APPROACH #2

The foregoing basic alternatives are amenable to many possible variations, which may be seen as necessary to adapt to the domestic requirements of each sponsoring nation. At this preliminary stage of reflection, it would be a mistake to develop the scheme to a point of refinement. When the basic objectives and constraints are clear so that the domestic requirements of each country will be identified, greater detail can be provided with greater confidence.

6.2.3 General Organizational Requirements for the Launching of a U.S.-Sponsored Multinational Center in Europe

The launching of a U.S.-sponsored multinational center calls for a head-on U.S. involvement in organizational developments including the formation of a new participation framework (as compared to the existing facilities), and a full fledged regulatory/control regime (not required by existing facilities). These required organizational developments are discussed in order.

The participation framework should account for (1) a distribution of responsibilities reflecting new memberships, and (2) adequate financing mechanisms supporting the center's formation and operation. First, the access to the decision making process by the joining nations is central to their acceptance of a multinational center as an alternative to their national plans.

Second, adequate financing mechanisms should be designed so as to reflect the institutional context in which the U.S.-sponsored center will operate. For instance, as it was mentioned earlier, the Mediterranean center alone could have different financing schemes. Under the Reference Case of Approach #2, the Sponsoring nations would have to provide additional equity financing participation for the launching of a large multinational reprocessing and a permanent storage center. This would imply a direct financing obligation on the part of the sponsoring nations, and AFR storage service fees would probably come only as a backup financing mechanism in the diversification process.

However, this could prove to be institutionally impractical, the reason being that the Northern European countries would find it difficult to finance a multinational Mediterranean reprocessing center, when their initial plan called for such a center in Sweden (Nordic Council Agreement). The only incentive for these countries to join a mediterranean alternative would be to find a permanent storage solution. Under the Modification #1 of Approach #2, the Northern Europe countries would part from the Mediterranean center for the reprocessing operation, and would finance their own multinational center (as planned under the Nordic Council Agreement), but would still tie-in with the Mediterranean center for the permanent storage of their spent fuel and/or HLW.

Under such an arrangement, the equity financing for the permanent storage facility only would be required, and would involve major users Sweden and Switzerland, backed by the U.S., and the host country through manpower contributions. The financing of the multinational reprocessing center servicing Switzerland, Italy, and Spain in the present case would come later and would be totally provided by the AFR and permanent storage fees coming from the Northern Europe and other countries. In this case, the Northern European countries would only provide an indirect source of financing for the Mediterranean reprocessing center, while engaging in their own multinational reprocessing operation, and thus avoiding possible institutional difficulties.

Finally, a full fledged regulatory/control regime would have to be developed due to the very nature of the multinational center. The General Council (under the Approach #1) and the Commission (under the Approach #2) would be primarily responsible for developing such a regime under the guidelines of the Non-Proliferation Treaty (in the first case) or of the Convention (in the second case). Important control/regulatory development will, however, be required for the timely implementation of an acceptable regime; this will have to be developed on an ad hoc basis between the nonproliferation control entity and the host country. Finally, to ensure effective control an audit and materials accounting staff will have to be supported by the General Council or the Commission, according to the case.

7.0 TECHNICAL/FINANCIAL EVALUATION

7.1 INTRODUCTION

Section 7.0 provides a technical/financial evaluation for a concept supportive of a European Regional Spent Fuel Logistics System (ERSFLS). The ERSFLS concept evaluated in this section reflects a multinational center serving the non-URG countries (see Approach #2 Reference Case described in Section 4.2).

Section 7.0 provides the following information:

Section 7.2 - Technical description of a preferred ERSFLS.

Section 7.3 - Description and evaluation of the financial concept underlying the preferred ERSFLS.

Section 7.4 - Description of the project finding requirements for a preferred ERSFLS.

7.2 TECHNICAL DESCRIPTION OF PREFERRED ERSFSLS CONCEPT

Figure 7.2-1 and 7.2-2 show the layout and transportation system requirements, respectively, for a preferred ERSFSLS concept. The ERSFSLS site is considered to be located at a suitable geologic site on continental Europe. Average sea lane transport distance from fuel generation sources is approximately 1300 miles. Additional rail links of 200 to 300 miles are required at each end of the transport loop. Operations begin in 1985 with 2 ships and 5 casks supporting the transportation link. The ships are about 3000 dead weight tons and carry 4 casks. The ships have been modified to provide double hull safety. The casks are large rail transport size casks with capacity for 10 PWR and 21 BWR fuel elements. The ERSFSLS begins 1985 operation with a receiving facility, a single water basin, and supporting facilities. During operation, the ships arrive at nearby port facility and unload their casks. The casks are transferred by rail to the receiving facility where the casks are unloaded. The spent fuel is then transferred to the water basins and the casks are returned for future trips. Operations continue in this manner from 1985 to 2000. New ships, casks, and water basins are added to keep pace with the spent fuel shipments. By 2000 the expected ERSFSLS complement includes 5 ships, 29 casks and 17 water basins (1025 MTU each). Following the decision in 1990 to proceed with recovery and waste disposal, new facilities are constructed and begin operations in 2000. These facilities include a recovery plant, waste management facilities, waste canisters, a packaging facility and geologic repositories for permanent disposal of waste. During operation, casks are transferred from the receiving facility to the recovery plant. The recovery plant (3400 MTHM/YR) has capacity that is somewhat larger than the spent fuel receiving rate thus allowing for drawdown of the spent fuel in the water basins. Waste from the recovery operations

Figure 7.2-1: Layout of Preferred Concept with Geologic Repository

European Spent Fuel Logistics System Transportation Requirements

is solidified and packaged into canisters. The canisters are about the same size as spent fuel assemblies, thus allowing for their transportation in spent fuel casks should the need arise and also allows the geologic repositories to be used for either spent fuel or canisterized waste as required.

7.3 FINANCIAL CONCEPT

7.3.1 Financial Characteristics

The recommended concept for a European Regional Spent Fuel Logistics System (ERSFLS) as operated by a European Regional Enterprise (ERE) has the following financial characteristics:

- a) Function: The ERE is considered to be a complete operating entity formed for the purpose of disposing of spent fuel from nuclear power plants. The ERE entity receives the fuel at a shipping dock at the reactor and is the only entity with which the utility companies deal with to dispose of their spent fuel. However, for purposes of analysis the ERE has been considered as made up of four financial entities. These cover the functions of transportation, interim storage, recovery, and permanent storage.
- b) Fuel Populations: The ERSFLS is designed for and is considered to dispose of fuel from the European Regional countries from 1985 through 2030. The population includes current reactors and projected new reactors to be in operation by the year 2000. The year by year spent fuel shipment to the ERSFLS has cumulative values of:

<u>Year</u>	<u>Cumulative Shipment - MTHM</u>
1990	3100
2000	18900
2030	104900

The cost analysis makes provision for the complete purchase and depreciation of facilities and equipment by completion of the study period (2030) with all capital costs chargeable to the 104900 MTHM.

- c) Location: The recommended ERSFLS is considered to be located at a suitable geologic site on Continental Europe. Average one-way shipping distances between the nearest sea ports are about 1300 miles. As neither the reactors nor the repository are considered to be located at a port, rail links are required at both ends of the shipping loop. The site is considered to have a sufficient infrastructure to support construction and operation of the facility at normal costs.
- d) Financing: The recommended ERSFLS is considered to be a private company with private financing which owns all of the ERSFLS except the permanent waste disposal facility. The permanent waste disposal facility is considered an activity of participating governments who have entrusted operation to the ERE. ERE ownership is maintained by investors who organize and manage the company and provide some capital as equity. Additional capital is borrowed from the financial community. It is considered that the financial communities assessment of the risks associated with ERE will be such that favorable borrowing cannot be provided without suitable guarantees being provided by the government(s) of the region and/or the U.S. With suitable guarantees very favorable credit provisions may be obtained. The ERE is considered to have government guarantees and to have the following credit capability:
- 1) The ERE provides a minimum of 10% of any capital payment. The remaining 90% or less of capital payments are borrowed.
 - 2) During the initial construction period when capital costs are being incurred but no income is available, the ERE will pay no interest or

payments toward principal. Interest will be accrued however and capitalized as part of the ERE investment during the first year of operation.

- 3) Loans are paid back in a manner similar to that of mortgages at 10% interest.

e. Pricing: The ERE adjusts its service charge to the utilities for spent fuel received to obtain the established rate of return on investment. This return is based on the total project capitalized investments without financing and before taxes. Pricing is done separately for each ERSFLS function as follows:

- 1) Transportation: A fixed fee is charged for each KgU of spent fuel brought to the ERSFLS. The fee is adjusted to bring a return on investment of 12½% over the period from 1980 to 2030.
- 2) Temporary Storage: A fixed storage fee is charged for each KgU of spent fuel brought to the ERSFLS before 2000. This fuel is placed in temporary storage. Fuel received after 2000 is handled in the temporary storage facility and a small handling fee (\$15 KgU) is charged. Spent fuel received before 2000 will be withdrawn from the temporary storage between 2000 and 2030 when no income is being received for this fuel. Costs will be incurred during this period. These costs are in the fixed fee received prior to 2000 as a pre-payment. The storage fee is adjusted to provide a 12½% return on investment.
- 3) Recovery: A rebate is provided by the ERE to the utility for each KgU of spent fuel completing the recovery process. This rebate is a portion of funds received from sale of

the recovered products. The value of recovered products is considered to be about 260 \$/KgU in 1990 with a real price increase due to increasing scarcity of fuel of about 1.2% per year. This results in an average value of 349 \$/KgU over the recovery period from 2000 to 2030. The rebate is adjusted such that a 17½% return on investment is provided in the period through 2030.

- 4) Permanent Storage: Permanent storage is considered to be a government activity. A fixed fee is charged on each KgU received by the facility. This fee is adjusted to allow the owner governments to recover their costs. The fee is determined on the basis of 100% borrowing at 7% which is equivalent to an ROI of 7%.
- f) Taxes: As a private concern the ERE is considered liable for taxation by the host country in accordance with whatever treaty arrangements are made. These arrangements are unknown at this time but, for analysis purposes, an allowance of 45% of profits have been set aside for this purpose. (No carry over for losses has been provided).

7.3.2 Financial Operation

- a) The operation of the recommended ERSFLE is divided into two separate phases. In the first phase the system is operated as a temporary storage facility. This phase covers transportation and temporary storage activities prior to the year 2000. During this phase the operation can be characterized by the data shown below:

FINANCIAL CHARACTERISTICS
FOR TEMPORARY STORAGE PHASE

<u>Item</u>	<u>Amount Dollars</u>
Total Capitalized Investment	1.05 Billion
Annual Sales (Representative Year 1993)	210 Million
Annual Net Income After Taxes (Representative Year 1993)	40 Million
Annual Taxes Paid (Representative Year 1993)	28 Million

In the second phase, the system is operated as a total spent fuel center and includes transportation, temporary storage, recovery and permanent storage of waste. This phase is characterized by the following:

FINANCIAL CHARACTERISTICS
FOR SPENT FUEL CENTER PHASE

<u>Item</u>	<u>Amount Dollars</u>
Total Capitalized Investment	4.50 Billion
Annual Sales (Representative Year 2015)	1.01 Billion
Annual Net Income After Taxes (Representative Year 2015)	.37 Billion
Annual Taxes Paid (Representative Year 2015)	.29 Billion

- b) Figure 7.3-1 shows the breakdown of the total capital costs in terms of the functions performed by the ERSFSL. Three sources of funds are available for purchase of these facilities:
- 1) Equity capital provided by the owners of the ERSFSL.
 - 2) Cash provided by ERSFSL operations.
 - 3) Loans from the financial community and later paid back from cash generated from ERSFSL operations.

FUNCTION ● CAPITAL ITEM	ITEM TOTAL	FUNCTION TOTAL
TRANSPORTATION ● SHIPS ● CASKS ● CASK MAINTENANCE ● CAPITALIZED INTEREST	.07 .13 .02 .01	.23 BILLION
INTERIM STORAGE ● WATER BASINS ● SUPPORTING FACILITIES ● LOW LEVEL WASTE ● CAPITALIZED INTEREST	.79 .01 .06 .09	.95 BILLION
RECOVERY & WASTE MANAGEMENT ● RECOVERY ● HIGH LEVEL WASTE ● CAPITALIZED INTEREST	.80 .84 1.12	2.76 BILLION
PERMANENT WASTE STORAGE ● PACKAGING ● GEOLOGIC REPOSITORY	.15 .41	.56 BILLION
4.50 BILLION		

Figure 7.3-1: Summary of Capital Investment for ERSFLS - Preferred Concept

Figure 7.3-2 shows the sources of these funds in the purchase of the 4.5 billion dollars worth of ERSFSL facilities. Note that the maximum investment by the owners in facilities is about \$65 million and maximum indebtedness is \$4 billion.

- c) During the temporary storage phase income is received from the utilities for the service of storage of the spent fuel. Figure 7.3-3a shows the total income received from fuel shipped to 2000. The income shown in Figure 7.3-3 is associated with costs for the following functions:

- 1) Transportation
- 2) Temporary storage
- 3) Permanent disposal of recovery waste.

While the function of permanent disposal is not performed during this phase, a charge is made for it upon receipt of the fuel. Figure 7.3-3b shows the split of income between these functions. Actual distribution of the income during this period to various parties involved is shown in Figure 7.3-3c.

- d) During the spent fuel center phase, income is received from utilities as a service charge and from fuel fabricators for the recovered uranium and plutonium products. Figure 7.3-4a shows the split of income from these sources. During this phase, costs are incurred for the following functions:

- 1) Transportation
- 2) Temporary storage
- 3) Recovery
- 4) Permanent disposal of recovery waste

New fuel being received during this phase does not require temporary storage and no storage charge is levied on this fuel. However, a handling fee is

Figure 7.3-2: Sources of Funds for Facility Acquisition (Preferred Concept)

Figure 7.3-3: Disposition of ERE Income During the Temporary Storage Phase (1985 through 2000)

Figure 7.3-4: Disposition of ERE Income During the Spent Fuel Center Phase (2000 through 2030)

levied. Additional costs are being incurred due to the fact that fuel from the temporary storage phase remains in the storage pools until it is recovered.

Figure 7.3-4b shows the split of an income between the above functions. Note that during this period the utilities pay a service charge of \$43.20 and receive a payment for the fuel used in recovery of \$102.80. This provides a net credit to the utilities of \$59.40. Actual distribution of income during this period is shown in Figure 7.3-4c.

- e) Net cost (or income) to the utilities for spent fuel services are a function of:
- 1) Service charge paid at time of dispatch of spent fuel to the ERSFLS.
 - 2) Payment received (or charge paid) as a result of recovery operations.
 - 3) Purchase of stock in ERE.
 - 4) Dividends received from ERE.

Items 3) and 4) depend upon the degree of participation by the utilities in the equity of the ERE. Figure 7.3-5 summarizes the net cost (or income) over the total period of interest for 0%, 50% and 100% equity participation in the ERE by the utilities providing the spent fuel. As shown, with reprocessing the net is an income of \$23/KgU at 0% equity participation and \$130/KgU at 100% participation.

- f) Figures 7.3-6a, b, c & d are the yearly cash reports for the ERE. The second column shows the total revenue received by the ERE and is the sum of the service charge and the sale of recovered products. The third column shows the total cash that would be

% OF ERE OWNED BY UTILITIES	0%	50%	100%
TOTAL DOLLARS IN MILLIONS			
TRANSPORTATION SERVICE CHARGE	2186	2186	2186
TEMPORARY STORAGE SERVICE CHARGE	2323	2323	2323
TEMPORARY STORAGE HANDLING CHARGE	1323	1323	1323
PERMANENT STORAGE SERVICE CHARGE	768	768	768
DIVIDENDS LESS EQUITY PURCHASES (WITHOUT REPROCESSING)	0	-58	-116
CREDIT FOR SPENT FUEL REPROCESSED	-9040	-9040	-9010
DIVIDENDS LESS EQUITY PURCHASES (REPROCESSING)	0	-5530	-11070
NET	-2440	-8028	-13626
DOLLARS PER KgU SHIPPED			
NET	-23 \$/KgU	-77 \$/KgU	-130 \$/KgU
NOTES: COSTS AND INCOMES ARE TOTAL SPENT OVER PERIOD FROM 1980 THROUGH 2030 PER KgU COSTS/INCOMES ARE FOR TOTAL SPENT FUEL PROFILE THROUGH 2030 (i.e. 104,800,000 KgU). NO DISCOUNTING TO PRESENT VALUE.			

Figure 7.3-5: Net Cost to Utilities for Spent Fuel Logistics

YEARLY CASH FLOW STATEMENT
DOLLARS IN MILLIONS

UNFINANCED ENTERPRISE BEFORE TAX					OWNERS	
YEAR	ANNUAL CASH IN	ANNUAL CASH OUT	ANNUAL NET CASH	CUM NET CASH	ANNUAL NET CASH	CUM NET CASH
1978	.0	4.3	-4.3	-4.3	-.4	-.4
1979	.0	1.6	-1.6	-5.9	-.2	-.6
1980	.0	2.6	-2.6	-8.5	-.3	-.9
1981	.0	4.3	-4.3	-12.8	-.4	-1.3
1982	.0	4.3	-4.3	-17.0	-.4	-1.7
1983	.0	2.4	-2.4	-19.5	-.2	-1.9
1984	.0	.4	-.4	-19.9	-.0	-2.0
1985	7.7	35.8	-28.2	-48.0	-8.6	-10.5
1986	8.8	5.1	3.6	-44.4	-1.6	-12.2
1987	10.3	20.5	-10.2	-54.6	-4.4	-16.5
1988	11.4	6.7	4.7	-49.8	-2.0	-18.6
1989	12.6	7.3	5.3	-44.5	-1.5	-20.0
1990	14.5	8.2	6.3	-38.2	-.5	-20.6
1991	18.1	9.9	8.2	-30.0	1.2	-19.3
1992	21.8	25.2	-3.4	-33.4	-.4	-19.7
1993	26.3	14.4	12.0	-21.5	2.5	-17.1
1994	28.8	27.7	1.0	-20.5	1.1	-16.1
1995	30.8	17.0	13.8	-6.7	3.0	-13.0
1996	34.7	18.9	15.8	9.1	3.9	-9.2
1997	37.3	21.4	15.9	25.0	4.4	-4.8
1998	40.8	35.4	5.5	30.5	2.9	-1.9
1999	43.7	23.7	20.0	50.5	5.2	3.2
2000	46.3	26.6	19.8	70.3	5.5	8.7
2001	48.8	39.7	9.1	79.3	3.7	12.4
2002	51.2	29.2	22.0	101.4	5.6	18.0
2003	53.7	29.0	24.6	126.0	6.1	24.1
2004	56.1	30.2	25.9	151.9	6.5	30.6
2005	58.5	50.1	8.4	160.3	7.7	38.3
2006	61.0	33.0	27.9	188.3	10.3	48.7
2007	61.0	46.0	14.9	203.2	9.5	58.2
2008	61.0	33.0	27.9	231.1	10.8	69.0
2009	61.0	33.0	27.9	259.0	10.7	79.7
2010	61.0	33.0	27.9	287.0	10.5	90.3
2011	61.0	33.0	27.9	314.9	10.4	100.6
2012	61.0	40.8	20.1	335.0	10.0	110.7
2013	61.0	33.0	27.9	362.9	10.7	121.4
2014	61.0	38.2	22.7	385.7	10.7	132.1
2015	61.0	34.6	26.4	412.0	10.9	143.0
2016	61.0	33.0	27.9	440.0	10.9	153.9
2017	61.0	34.3	26.6	466.6	10.6	164.6
2018	61.0	39.5	21.4	488.0	10.6	175.2
2019	61.0	33.0	27.9	515.9	11.2	186.4
2020	61.0	46.0	14.9	530.8	8.9	195.3
2021	61.0	39.5	21.4	552.3	10.1	205.4
2022	61.0	33.0	27.9	580.2	10.8	216.2
2023	61.0	33.0	27.9	608.1	10.6	226.8
2024	61.0	33.0	27.9	636.0	10.4	237.1
2025	61.0	44.7	16.2	652.3	9.2	246.4
2026	61.0	33.0	27.9	680.2	10.3	256.7
2027	61.0	53.8	7.1	687.3	6.0	262.7
2028	61.0	33.0	27.9	715.2	8.1	270.8
2029	61.0	39.5	21.4	736.7	5.2	276.0
2030	61.0	34.6	26.4	763.0	4.4	280.5

Figure 7.3-6a Cash Report for Transportation through 2030

-- Geologic Concept --

YEARLY CASH FLOW STATEMENT

DOLLARS IN MILLIONS

UNFINANCED ENTERPRISE
BEFORE TAX

OWNERS

YEAR	ANNUAL CASH IN	ANNUAL CASH OUT	ANNUAL NET CASH	CUM NET CASH	ANNUAL NET CASH	CUM NET CASH
1978	.0	34.1	-34.1	-34.1	-3.4	-3.4
1979	.0	13.0	-13.0	-47.1	-1.3	-4.8
1980	.0	30.1	-30.1	-77.1	-3.0	-7.8
1981	.0	37.5	-37.5	-114.6	-3.8	-11.6
1982	.0	48.6	-48.6	-163.3	-4.9	-16.5
1983	.0	40.9	-40.9	-204.1	-4.2	-20.7
1984	.0	21.2	-21.2	-225.4	-2.2	-22.9
1985	51.2	149.6	-98.4	-323.8	-42.1	-65.0
1986	58.7	56.5	2.1	-321.6	-2.0	-67.0
1987	69.0	52.7	16.3	-305.3	4.9	-62.1
1988	76.5	54.8	21.7	-283.6	8.2	-53.9
1989	84.0	71.9	12.2	-271.5	7.9	-46.0
1990	96.7	79.6	17.1	-254.4	11.4	-34.5
1991	121.0	81.3	39.7	-214.7	21.3	-13.3
1992	145.5	86.8	58.7	-156.0	30.5	17.2
1993	175.9	77.8	98.0	-57.9	44.8	62.0
1994	192.2	75.3	116.9	59.0	50.7	112.6
1995	206.1	65.1	141.1	200.0	56.5	169.2
1996	231.8	48.0	183.8	383.8	70.0	239.3
1997	249.6	30.1	219.5	603.3	80.0	319.3
1998	273.0	19.9	253.2	856.5	92.5	411.8
1999	292.3	18.1	274.1	1130.6	101.6	513.5
2000	33.3	16.4	16.9	1147.5	-80.0	433.5
2001	35.1	16.4	18.7	1166.2	-78.2	355.2
2002	36.9	16.4	20.4	1186.6	-76.4	278.8
2003	38.6	16.4	22.2	1208.7	-74.6	204.3
2004	40.4	16.4	23.9	1232.6	-72.7	131.6
2005	42.1	16.4	25.7	1258.3	-35.4	96.2
2006	43.9	16.4	27.4	1285.7	-29.9	66.3
2007	43.9	16.4	27.4	1313.1	-26.1	40.2
2008	43.8	16.4	27.4	1340.5	-22.0	18.2
2009	43.9	16.4	27.4	1367.9	-16.2	2.1
2010	43.9	16.4	27.4	1395.4	-9.5	-7.5
2011	43.9	16.4	27.4	1422.8	-5.3	-12.8
2012	43.9	16.4	27.4	1450.2	-6.6	-13.4
2013	43.9	16.4	27.4	1477.6	3.6	-9.8
2014	43.9	16.4	27.4	1505.0	7.8	-2.0
2015	43.9	16.4	27.4	1532.4	11.4	9.3
2016	43.9	16.4	27.4	1559.8	13.7	23.0
2017	43.9	16.4	27.4	1587.2	14.7	37.7
2018	43.9	16.4	27.4	1614.6	14.9	52.7
2019	43.9	16.4	27.4	1642.0	15.1	67.7
2020	43.9	16.4	27.4	1669.5	15.1	82.8
2021	43.9	16.4	27.4	1696.9	15.1	97.9
2022	43.9	16.4	27.4	1724.3	15.1	113.0
2023	43.9	16.4	27.4	1751.7	15.1	128.0
2024	43.9	16.4	27.4	1779.1	15.1	143.1
2025	43.9	16.4	27.4	1806.5	15.1	158.2
2026	43.9	16.4	27.4	1833.9	15.1	173.3
2027	43.9	16.4	27.4	1861.3	15.1	188.4
2028	43.9	16.4	27.4	1888.7	15.1	203.4
2029	43.9	16.4	27.4	1916.1	15.1	218.5
2030	43.9	16.4	27.4	1943.6	15.1	233.6

Figure 7.3-6b Cash Report for Interim Storage through 2030

-- Geologic Concept --

YEARLY CASH FLOW STATEMENT
DOLLARS IN MILLIONS

YEAR	UNFINANCED ENTERPRISE BEFORE TAX				OWNERS	
	ANNUAL CASH IN	ANNUAL CASH OUT	ANNUAL NET CASH	CUM NET CASH	ANNUAL NET CASH	CUM NET CASH
1978	.0	.0	.0	.0	.0	.0
1979	.0	.0	.0	.0	.0	.0
1980	.0	.0	.0	.0	.0	.0
1981	.0	.0	.0	.0	.0	.0
1982	.0	.0	.0	.0	.0	.0
1983	.0	.0	.0	.0	.0	.0
1984	.0	.0	.0	.0	.0	.0
1985	.0	.0	.0	.0	.0	.0
1986	.0	.0	.0	.0	.0	.0
1987	.0	.0	.0	.0	.0	.0
1988	.0	.0	.0	.0	.0	.0
1989	.0	.0	.0	.0	.0	.0
1990	.0	.0	.0	.0	.0	.0
1991	.0	64.8	-64.8	-64.8	-6.5	-6.5
1992	.0	64.8	-64.8	-129.6	-6.6	-13.1
1993	.0	210.7	-210.7	-340.3	-21.3	-34.4
1994	.0	129.8	-129.8	-470.1	-13.3	-47.8
1995	.0	210.9	-210.9	-681.1	-21.6	-69.3
1996	.0	340.7	-340.7	-1021.7	-34.8	-104.2
1997	.0	340.9	-340.9	-1362.6	-35.1	-139.2
1998	.0	195.5	-195.5	-1558.1	-20.7	-159.9
1999	.0	324.6	-324.6	-1882.7	-33.6	-193.5
2000	603.8	929.5	-325.8	-2208.5	-102.4	-296.0
2001	706.2	45.1	661.1	-1547.4	256.1	-39.9
2002	723.1	45.1	678.0	-869.4	253.4	223.5
2003	740.0	45.1	694.9	-174.5	270.6	494.1
2004	750.2	45.1	705.1	530.5	273.8	767.9
2005	755.9	45.1	711.8	1242.3	275.0	1042.9
2006	770.5	45.1	725.3	1967.7	279.6	1322.5
2007	787.4	45.1	742.3	2709.9	285.8	1608.3
2008	797.5	45.1	752.4	3462.3	287.9	1896.2
2009	811.1	45.1	765.9	4228.3	291.6	2187.8
2010	824.6	45.1	779.5	5007.8	294.9	2482.8
2011	831.4	45.1	786.2	5794.0	294.1	2776.8
2012	844.9	45.1	799.8	6593.8	296.5	3073.3
2013	858.4	45.1	813.3	7407.1	298.4	3371.7
2014	875.4	45.1	830.2	8237.3	301.6	3673.4
2015	885.5	45.1	840.4	9077.7	300.5	3973.9
2016	899.0	45.1	853.9	9931.6	300.6	4274.6
2017	912.6	45.1	867.4	10799.0	300.0	4574.6
2018	926.1	45.1	881.0	11680.0	298.6	4873.1
2019	936.2	45.1	891.1	12571.1	294.5	5167.6
2020	953.2	45.1	908.0	13479.1	503.5	5671.1
2021	966.7	45.1	921.6	14400.7	506.9	6178.0
2022	976.8	45.1	931.7	15332.4	512.4	6690.4
2023	993.8	45.1	948.6	16281.0	521.7	7212.2
2024	1007.3	45.1	952.2	17243.2	529.2	7741.3
2025	1020.8	45.1	975.7	18218.8	536.6	8278.0
2026	1034.4	45.1	939.2	19208.1	544.1	8822.0
2027	1047.9	45.1	1002.8	20210.8	551.5	9373.6
2028	1061.4	45.1	1016.3	21227.1	559.0	9932.5
2029	1074.9	45.1	1029.8	22256.9	566.4	10498.9
2030	1088.5	45.1	1043.3	23300.3	573.8	11072.7

Figure 7.3-6c Cash Report for Recovery through 2030
-- Geologic Concept --

YEARLY CASH FLOW STATEMENT
DOLLARS IN MILLIONS

YEAR	UNFINANCED ENTERPRISE				OWNERS	
	ANNUAL CASH IN	ANNUAL CASH OUT	ANNUAL NET CASH	CUM NET CASH	ANNUAL NET CASH	CUM NET CASH
1978	.0	.0	.0	.0	.0	.0
1979	.0	.0	.0	.0	.0	.0
1980	.0	.0	.0	.0	.0	.0
1981	.0	.0	.0	.0	.0	.0
1982	.0	.0	.0	.0	.0	.0
1983	.0	.0	.0	.0	.0	.0
1984	.0	.0	.0	.0	.0	.0
1985	2.7	.0	2.7	2.7	2.7	2.7
1986	3.1	.0	3.1	5.8	3.1	5.8
1987	3.6	.0	3.6	9.4	3.6	9.4
1988	4.0	.0	4.0	13.4	4.0	13.4
1989	4.4	.0	4.4	17.8	4.4	17.8
1990	5.1	.0	5.1	22.9	5.1	22.9
1991	6.4	3.5	2.9	25.8	6.0	28.9
1992	7.6	3.5	4.2	30.0	6.9	35.8
1993	9.2	16.7	-7.5	22.5	6.8	42.7
1994	10.1	9.1	1.0	23.5	6.9	49.6
1995	10.8	14.7	-3.8	19.7	6.2	55.8
1996	12.2	23.7	-11.5	8.2	5.2	61.0
1997	13.1	23.7	-10.6	-2.4	3.9	64.9
1998	14.3	13.5	.8	-1.6	4.0	68.9
1999	15.4	13.3	2.0	.5	3.8	72.6
2000	16.3	32.4	-16.1	-15.6	-6.1	66.6
2001	17.1	22.3	-5.2	-20.8	-5.3	61.3
2002	18.0	22.3	-4.3	-25.1	-5.9	55.3
2003	18.9	22.3	-3.5	-28.6	-6.5	48.9
2004	19.7	22.3	-2.6	-31.2	-7.1	41.8
2005	20.6	22.3	-1.8	-32.9	-7.6	34.1
2006	21.4	22.3	-.9	-33.9	-8.2	25.9
2007	21.4	11.3	10.1	-23.7	-8.5	17.4
2008	21.4	22.3	-.9	-24.6	-10.0	7.4
2009	21.4	22.3	-.9	-25.5	-11.5	-4.1
2010	21.4	22.3	-.9	-26.4	-12.9	-17.0
2011	21.4	22.3	-.9	-27.3	-14.0	-31.0
2012	21.4	22.3	-.9	-28.2	-15.1	-46.1
2013	21.4	22.3	-.9	-29.1	-15.1	-61.2
2014	21.4	22.3	-.9	-30.0	-15.8	-77.0
2015	21.4	22.3	-.9	-30.9	-16.0	-93.0
2016	21.4	11.3	10.1	-20.8	-14.1	-107.1
2017	21.4	22.3	-.9	-21.7	-13.8	-120.8
2018	21.4	22.3	-.9	-22.6	-14.3	-135.2
2019	21.4	22.3	-.9	-23.5	-15.0	-150.1
2020	21.4	22.3	-.9	-24.4	-14.6	-164.7
2021	21.4	22.3	-.9	-25.3	-15.3	-180.1
2022	21.4	22.3	-.9	-26.2	-16.2	-196.3
2023	21.4	22.3	-.9	-27.1	-17.4	-213.7
2024	21.4	22.3	-.9	-28.0	-18.7	-232.4
2025	21.4	11.3	10.1	-17.9	-18.0	-250.4
2026	21.4	22.3	-.9	-18.8	-20.4	-270.8
2027	21.4	22.3	-.9	-19.7	-24.5	-295.3
2028	21.4	22.3	-.9	-20.6	-28.8	-324.2
2029	21.4	22.3	-.9	-21.5	-35.8	-360.0
2030	21.4	11.3	10.1	-11.3	-38.6	-398.6

Figure 7.3-6d Cash Report for Permanent Storage Through 2030
-- Geologic Concept --

spent by the ERE if all capital purchases were made by the ERE without financing. This column is the sum of operation and maintenance (O & M) expenses and the total cost of capital purchases. The fourth column is the net of the cash transactions of the ERE if operating solely on its own funds. This column is used to set the service charge to the utilities by the following:

$$\begin{array}{rcl} \text{Sum of Present Value} & & \text{Sum of Present Value} \\ \text{of net Cash In} & = & \text{of net Cash In} \end{array}$$

For this calculation the service charge of column 2 is adjusted until the rate used in present value calculations becomes the selected ROI.

In this way, the service charge is determined on the basis that the total capital investment should earn at the desired rate regardless of the method of financing. The service charge is therefore independent of financing arrangements.

Figures 7.3-6a, b, c, & d also show another cash line in columns 6 and 7. This is the owners cash line. Minus values in column 6 indicate an equity investment (stock purchase) by the owners. Plus values indicate a dividend to the owners. The cumulative total of the required equity investments is \$75 million dollars for all functions.

Figures 7.3-7a, b, c, & d show profit and loss report for each of the years of operation. These reports are based upon the service charge previously determined and takes into account interest on capital loans, depreciation and taxation to provide a realistic performance estimate of profit and loss for the baseline ERE.

DOLLARS IN MILLIONS

YEAR	REP REVENUE	SERV CH REVENUE	TOTAL REVENUE	OPER EXPEN	INT EXPEN	DEP EXPEN	TOTAL EXPEN	TAXES	NET INCOME
1978	.0	.0	.0	.0	.0	.0	.0	.0	-0.0
1979	.0	.0	.0	.0	.0	.0	.0	.0	-0.0
1980	.0	.0	.0	.0	.0	.0	.0	.0	-0.0
1981	.0	.0	.0	.0	.0	.1	.1	.0	-0.1
1982	.0	.0	.0	.0	.0	.1	.1	.0	-0.1
1983	.0	.0	.0	.0	.0	.1	.1	.0	-0.1
1984	.0	.0	.0	.0	.0	.1	.1	.0	-0.1
1985	.0	7.7	7.7	4.6	4.4	2.5	11.6	.0	-3.9
1986	.0	8.8	8.8	5.1	4.3	2.5	12.0	.0	-3.2
1987	.0	10.3	10.3	6.2	5.5	3.2	15.0	.0	-4.6
1988	.0	11.4	11.4	6.7	5.4	3.2	15.4	.0	-4.0
1989	.0	12.6	12.6	7.3	5.3	3.2	15.8	.0	-3.2
1990	.0	14.5	14.5	8.2	5.2	3.2	16.6	.0	-2.1
1991	.0	18.1	18.1	9.9	5.0	3.2	18.1	.0	-0.1
1992	.0	21.8	21.8	12.2	6.0	3.9	22.1	.0	-0.3
1993	.0	26.3	26.3	14.4	5.8	3.9	24.1	1.0	1.2
1994	.0	28.8	28.8	16.1	6.6	4.5	27.2	.7	.9
1995	.0	30.8	30.8	17.0	6.4	4.5	27.9	1.3	1.6
1996	.0	34.7	34.7	18.9	6.1	4.5	29.4	2.4	2.9
1997	.0	37.3	37.3	20.1	5.9	4.6	30.5	3.1	3.7
1998	.0	40.8	40.8	22.4	6.7	5.2	34.2	3.0	3.6
1999	.0	43.7	43.7	23.7	6.3	5.2	35.2	3.8	4.7
2000	.0	46.3	46.3	25.0	5.9	5.3	36.2	4.6	5.6
2001	.0	48.8	48.8	26.7	6.6	5.9	39.2	4.3	5.3
2002	.0	51.2	51.2	27.9	6.1	6.0	40.0	5.0	6.2
2003	.0	53.7	53.7	29.0	5.5	6.0	40.5	5.9	7.2
2004	.0	56.1	56.1	30.2	4.8	6.0	41.0	6.8	8.3
2005	.0	58.5	58.5	31.9	5.7	4.4	41.9	7.5	9.1
2006	.0	61.0	61.0	33.0	5.3	4.4	42.7	8.2	10.0
2007	.0	61.0	61.0	33.0	6.1	4.3	43.4	7.9	9.6
2008	.0	61.0	61.0	33.0	5.8	4.3	43.1	8.0	9.8
2009	.0	61.0	61.0	33.0	5.4	4.3	42.8	8.2	10.0
2010	.0	61.0	61.0	33.0	5.1	4.3	42.4	8.3	10.2
2011	.0	61.0	61.0	33.0	4.7	4.3	42.0	8.5	10.4
2012	.0	61.0	61.0	33.0	4.9	4.1	42.0	8.5	10.4
2013	.0	61.0	61.0	33.0	4.6	4.1	41.7	8.7	10.6
2014	.0	61.0	61.0	33.0	4.6	3.8	41.5	8.8	10.7
2015	.0	61.0	61.0	33.0	4.5	3.9	41.4	8.8	10.8
2016	.0	61.0	61.0	33.0	4.1	3.9	41.0	9.0	11.0
2017	.0	61.0	61.0	33.0	3.8	3.9	40.8	9.1	11.1
2018	.0	61.0	61.0	33.0	4.0	3.8	40.8	9.1	11.1
2019	.0	61.0	61.0	33.0	3.6	3.8	40.4	9.2	11.3
2020	.0	61.0	61.0	33.0	4.4	4.9	42.3	8.4	10.3
2021	.0	61.0	61.0	33.0	4.5	4.9	42.4	8.4	10.2
2022	.0	61.0	61.0	33.0	4.1	4.8	41.9	8.6	10.5
2023	.0	61.0	61.0	33.0	3.6	4.8	41.5	8.8	10.7
2024	.0	61.0	61.0	33.0	3.1	4.8	40.9	9.0	11.0
2025	.0	61.0	61.0	33.0	3.6	5.8	42.5	8.3	10.2
2026	.0	61.0	61.0	33.0	3.1	5.8	41.9	8.6	10.5
2027	.0	61.0	61.0	33.0	4.3	10.4	47.8	5.9	7.3
2028	.0	61.0	61.0	33.0	3.4	10.4	46.8	6.4	7.8
2029	.0	61.0	61.0	33.0	3.0	13.6	49.6	5.1	6.2
2030	.0	61.0	61.0	33.0	1.7	15.2	49.9	5.0	6.1
TOTAL	.0	2186.3	2186.3	1189.4	224.7	233.9	1648.0	252.1	286.3
AVG	.0	41.3	41.3	22.4	4.2	4.4	31.1	4.8	5.4
\$/KG	.0	20.8	20.8	11.3	2.1	2.2	15.7	2.4	2.7

Figure 7.3-7a Profit and Loss Report for Transportation through 2030

-- Geologic Concept --

DOLLARS IN MILLIONS

YEAR	HANDLING FEE REVENUE	SERV CH REVENUE	TOTAL REVENUE	OPER EXPEN	INT EXPEN	DEP EXPEN	TOTAL EXPEN	TAXES	NET INCOME
1978	.0	.0	.0	.0	.0	.1	.1	.0	-.1
1979	.0	.0	.0	.0	.0	.2	.2	.0	-.2
1980	.0	.0	.0	.0	.0	.3	.3	.0	-.3
1981	.0	.0	.0	.1	.0	.4	.5	.0	-.5
1982	.0	.0	.0	.1	.0	.7	.7	.0	-.7
1983	.0	.0	.0	.1	.0	.9	.9	.0	-.9
1984	.0	.0	.0	.1	.0	.9	1.0	.0	-1.0
1985	.0	51.2	51.2	16.4	30.2	17.7	64.4	.0	-13.2
1986	.0	58.7	58.7	16.4	33.3	19.7	69.5	.0	-10.8
1987	.0	69.0	69.0	16.4	35.9	21.5	73.9	.0	-4.9
1988	.0	76.5	76.5	16.4	38.6	23.5	78.5	.0	-2.0
1989	.0	84.0	84.0	16.4	42.7	26.2	85.4	.0	-1.3
1990	.0	96.7	96.7	16.4	47.3	29.4	93.1	1.6	2.0
1991	.0	121.0	121.0	16.4	51.8	32.6	100.9	9.0	11.0
1992	.0	145.5	145.5	16.4	56.6	36.1	109.2	16.3	19.9
1993	.0	175.9	175.9	16.4	60.4	39.2	116.1	26.9	32.9
1994	.0	192.2	192.2	16.4	63.6	42.2	122.3	31.5	38.5
1995	.0	206.1	206.1	16.4	65.7	44.6	126.7	35.7	43.7
1996	.0	231.8	231.8	16.4	65.9	46.2	128.5	46.5	56.8
1997	.0	249.6	249.6	16.4	64.1	46.9	127.4	55.0	67.2
1998	.0	273.0	273.0	16.4	61.1	47.0	124.5	66.8	81.6
1999	.0	292.3	292.3	16.4	57.6	47.1	121.2	77.0	94.1
2000	33.3	.0	33.3	16.4	53.6	47.1	117.2	.0	-83.8
2001	35.1	.0	35.1	16.4	49.2	47.1	112.8	.0	-77.7
2002	36.9	.0	36.9	16.4	44.4	47.1	108.0	.0	-71.1
2003	38.6	.0	38.6	16.4	39.1	47.1	102.6	.0	-64.0
2004	40.4	.0	40.4	16.4	33.2	47.1	96.8	.0	-56.4
2005	42.1	.0	42.1	16.4	26.8	29.4	72.6	.0	-30.5
2006	43.9	.0	43.9	16.4	23.3	27.4	67.1	.0	-23.2
2007	43.9	.0	43.9	16.4	19.8	25.6	61.8	.0	-18.0
2008	43.9	.0	43.9	16.4	16.4	23.6	56.5	.0	-12.6
2009	43.9	.0	43.9	16.4	13.0	20.9	50.3	.0	-6.5
2010	43.9	.0	43.9	16.4	9.9	17.7	44.1	.0	-.2
2011	43.9	.0	43.9	16.4	7.1	14.5	38.1	2.6	3.2
2012	43.9	.0	43.9	16.4	4.8	11.0	32.2	5.2	6.4
2013	43.9	.0	43.9	16.4	3.0	7.9	27.3	7.5	9.1
2014	43.9	.0	43.9	16.4	1.6	4.9	23.0	9.4	11.5
2015	43.9	.0	43.9	16.4	.7	2.5	19.7	0.9	13.3
2016	43.9	.0	43.9	16.4	.2	.9	17.6	1.8	14.4
2017	43.9	.0	43.9	16.4	.1	.3	16.8	2.2	14.9
2018	43.9	.0	43.9	16.4	.0	.1	16.5	12.3	15.0
2019	43.9	.0	43.9	16.4	.0	.0	16.4	12.3	15.1
2020	43.9	.0	43.9	16.4	.0	.0	16.4	12.3	15.1
2021	43.9	.0	43.9	16.4	.0	.0	16.4	12.3	15.1
2022	43.9	.0	43.9	16.4	.0	.0	16.4	12.3	15.1
2023	43.9	.0	43.9	16.4	.0	.0	16.4	12.3	15.1
2024	43.9	.0	43.9	16.4	.0	.0	16.4	12.3	15.1
2025	43.9	.0	43.9	16.4	.0	.0	16.4	12.3	15.1
2026	43.9	.0	43.9	16.4	.0	.0	16.4	12.3	15.1
2027	43.9	.0	43.9	16.4	.0	.0	16.4	12.3	15.1
2028	43.9	.0	43.9	16.4	.0	.0	16.4	12.3	15.1
2029	43.9	.0	43.9	16.4	.0	.0	16.4	12.3	15.1
2030	43.9	.0	43.9	16.4	.0	.0	16.4	12.3	15.1
TOTAL	1322.9	2323.5	3646.4	757.1	1121.0	945.8	2823.9	586.2	236.2
AVG	25.0	43.8	68.8	14.3	21.2	17.8	53.3	11.1	4.5
\$/KG	79.4	139.4	218.7	45.4	67.2	56.7	169.4	35.2	14.2

Figure 7.3-7b Profit and Loss Report for
Interim Storage through 2030

-- Geologic Concept --

DOLLARS IN MILLIONS

YEAR	REP REVENUE	SERV. CH REVENUE	TOTAL REVENUE	OPER EXPEN	INT EXPEN	DEP EXPEN	TOTAL EXPEN	TAXES	NET INCOME
1978	.0	.0	.0	.0	.0	.0	.0	.0	.0
1979	.0	.0	.0	.0	.0	.0	.0	.0	.0
1980	.0	.0	.0	.0	.0	.0	.0	.0	.0
1981	.0	.0	.0	.0	.0	.0	.0	.0	.0
1982	.0	.0	.0	.0	.0	.0	.0	.0	.0
1983	.0	.0	.0	.0	.0	.0	.0	.0	.0
1984	.0	.0	.0	.0	.0	.0	.0	.0	.0
1985	.0	.0	.0	.0	.0	.0	.0	.0	.0
1986	.0	.0	.0	.0	.0	.0	.0	.0	.0
1987	.0	.0	.0	.0	.0	.0	.0	.0	.0
1988	.0	.0	.0	.0	.0	.0	.0	.0	.0
1989	.0	.0	.0	.0	.0	.0	.0	.0	.0
1990	.0	.0	.0	.0	.0	.0	.0	.0	.0
1991	.0	.0	.0	.1	.0	.2	.3	.0	-.3
1992	.0	.0	.0	.1	.0	.4	.6	.0	-.6
1993	.0	.0	.0	.3	.0	1.2	1.5	.0	-1.5
1994	.0	.0	.0	.4	.0	1.7	2.1	.0	-2.1
1995	.0	.0	.0	.5	.0	2.6	3.1	.0	-3.1
1996	.0	.0	.0	.8	.0	4.0	4.8	.0	-4.8
1997	.0	.0	.0	1.0	.0	5.5	6.5	.0	-6.5
1998	.0	.0	.0	1.2	.0	6.4	7.6	.0	-7.6
1999	.0	.0	.0	1.3	.0	7.9	9.2	.0	-9.2
2000	894.6	-290.8	603.8	45.1	231.6	136.6	413.3	85.7	104.7
2001	998.0	-291.8	706.2	45.1	227.6	136.6	409.3	133.6	163.3
2002	1014.9	-291.8	723.1	45.1	223.1	136.6	404.9	143.2	175.0
2003	1031.8	-291.8	740.0	45.1	218.3	136.6	400.0	153.0	187.0
2004	1042.0	-291.8	750.2	45.1	212.9	136.6	394.6	160.0	195.6
2005	1048.7	-291.8	756.9	45.1	206.9	136.6	388.7	165.7	202.6
2006	1062.3	-291.8	770.5	45.1	200.4	136.6	382.1	174.7	213.6
2007	1079.2	-291.8	787.4	45.1	193.3	136.6	375.0	185.6	226.8
2008	1089.3	-291.8	797.5	45.1	185.4	136.6	367.1	193.7	236.7
2009	1102.9	-291.8	811.1	45.1	176.7	136.6	358.4	203.7	249.0
2010	1116.4	-291.8	824.6	45.1	167.2	136.6	348.9	214.1	261.6
2011	1123.2	-291.8	831.4	45.1	156.7	136.6	338.4	221.8	271.1
2012	1136.7	-291.8	844.9	45.1	145.1	136.6	326.9	233.1	284.9
2013	1150.2	-291.8	858.4	45.1	132.5	136.6	314.2	244.9	299.3
2014	1167.1	-291.8	875.4	45.1	118.5	136.6	300.2	258.8	316.3
2015	1177.3	-291.8	885.5	45.1	103.1	136.6	284.8	270.3	330.4
2016	1190.8	-291.8	899.0	45.1	86.2	136.6	267.9	284.0	347.1
2017	1204.3	-291.8	912.6	45.1	67.7	136.6	249.4	298.4	364.8
2018	1217.9	-291.8	926.1	45.1	47.2	136.6	228.9	313.7	383.4
2019	1228.0	-291.8	936.2	45.1	24.7	136.6	206.4	328.4	401.4
2020	1244.9	-291.8	953.2	45.1	.0	.0	45.1	408.6	499.4
2021	1258.5	-291.8	966.7	45.1	.0	.0	45.1	414.7	506.9
2022	1268.6	-291.8	976.8	45.1	.0	.0	45.1	419.3	512.4
2023	1285.5	-291.8	993.8	45.1	.0	.0	45.1	426.9	521.7
2024	1299.1	-291.8	1007.3	45.1	.0	.0	45.1	433.0	529.2
2025	1312.6	-291.8	1020.8	45.1	.0	.0	45.1	439.1	536.6
2026	1326.1	-291.8	1034.4	45.1	.0	.0	45.1	445.1	544.1
2027	1339.7	-291.8	1047.9	45.1	.0	.0	45.1	451.2	551.5
2028	1353.2	-291.8	1061.4	45.1	.0	.0	45.1	457.3	559.0
2029	1366.7	-291.8	1074.9	45.1	.0	.0	45.1	463.4	566.4
2030	1380.3	-291.8	1088.5	45.1	.0	.0	45.1	469.5	573.8
TOTAL	36510.8	-9044.3	27466.4	1404.6	3125.2	2761.5	7291.3	9094.8	11080.3
AVG	688.9	-170.6	518.2	26.5	59.0	52.1	137.6	171.6	209.1
\$/KG*	348.2	-86.2	261.9	13.4	29.8	26.3	69.5	86.7	105.7
\$/KG**	414.0	-102.6	311.4	15.9	35.4	31.3	82.7	103.1	125.6

*Per KG Reprocessed

**Per KG Received

Figure 7.3-7c Profit and Loss Report for Recovery through 2030

-- Geologic Concept --

DOLLARS IN MILLIONS

YEAR	REP REVENUE	SERV CH REVENUE	TOTAL REVENUE	OPER EXPEN	INT EXPEN	DEP EXPEN	TOTAL EXPEN	TAXES	NET INCOME
1978	.0	.0	.0	.0	.0	.0	.0	.0	.0
1979	.0	.0	.0	.0	.0	.0	.0	.0	.0
1980	.0	.0	.0	.0	.0	.0	.0	.0	.0
1981	.0	.0	.0	.0	.0	.0	.0	.0	.0
1982	.0	.0	.0	.0	.0	.0	.0	.0	.0
1983	.0	.0	.0	.0	.0	.0	.0	.0	.0
1984	.0	.0	.0	.0	.0	.0	.0	.0	.0
1985	.0	2.7	2.7	.0	.0	.0	.0	.0	2.7
1986	.0	3.1	3.1	.0	.0	.0	.0	.0	3.1
1987	.0	3.6	3.6	.0	.0	.0	.0	.0	3.6
1988	.0	4.0	4.0	.0	.0	.0	.0	.0	4.0
1989	.0	4.4	4.4	.0	.0	.0	.0	.0	4.4
1990	.0	5.1	5.1	.0	.0	.0	.0	.0	5.1
1991	.0	6.4	6.4	.0	.2	.2	.4	.0	5.9
1992	.0	7.6	7.6	.0	.5	.4	.8	.0	6.8
1993	.0	9.2	9.2	.0	1.6	1.2	2.8	.0	6.4
1994	.0	10.1	10.1	.0	2.2	1.6	3.9	.0	6.2
1995	.0	10.8	10.8	.0	3.2	2.4	5.6	.0	5.3
1996	.0	12.2	12.2	.0	4.8	3.6	8.3	.0	3.9
1997	.0	13.1	13.1	.0	6.3	4.7	11.0	.0	2.1
1998	.0	14.3	14.3	.0	7.0	5.4	12.5	.0	1.9
1999	.0	15.4	15.4	.0	7.7	6.1	13.8	.0	1.5
2000	.0	16.3	16.3	7.0	9.3	7.3	23.6	.0	-7.4
2001	.0	17.1	17.1	7.0	10.0	8.1	25.2	.0	-8.0
2002	.0	18.0	18.0	7.0	10.7	8.9	26.5	.0	-8.6
2003	.0	18.9	18.9	7.0	11.4	9.6	28.0	.0	-9.2
2004	.0	19.7	19.7	7.0	12.0	10.4	29.4	.0	-9.7
2005	.0	20.6	20.6	7.0	12.5	11.2	30.7	.0	-10.1
2006	.0	21.4	21.4	7.0	13.0	11.9	31.9	.0	-10.5
2007	.0	21.4	21.4	7.0	12.6	12.1	31.8	.0	-10.3
2008	.0	21.4	21.4	7.0	12.9	12.9	32.9	.0	-11.5
2009	.0	21.4	21.4	7.0	13.2	13.7	33.9	.0	-12.5
2010	.0	21.4	21.4	7.0	13.4	14.4	34.9	.0	-13.4
2011	.0	21.4	21.4	7.0	13.5	15.0	35.5	.0	-14.1
2012	.0	21.4	21.4	7.0	13.5	15.6	36.2	.0	-14.8
2013	.0	21.4	21.4	7.0	13.5	15.7	36.2	.0	-14.7
2014	.0	21.4	21.4	7.0	13.4	16.1	36.6	.0	-15.1
2015	.0	21.4	21.4	7.0	13.3	16.3	36.7	.0	-15.3
2016	.0	21.4	21.4	7.0	12.4	15.4	34.9	.0	-13.5
2017	.0	21.4	21.4	7.0	12.3	15.3	34.7	.0	-13.3
2018	.0	21.4	21.4	7.0	12.3	15.8	35.2	.0	-13.8
2019	.0	21.4	21.4	7.0	12.2	16.4	35.7	.0	-14.3
2020	.0	21.4	21.4	7.0	12.1	16.6	35.7	.0	-14.3
2021	.0	21.4	21.4	7.0	12.0	17.3	36.4	.0	-15.0
2022	.0	21.4	21.4	7.0	11.8	18.3	37.1	.0	-15.7
2023	.0	21.4	21.4	7.0	11.6	19.4	38.0	.0	-16.6
2024	.0	21.4	21.4	7.0	11.2	20.8	39.1	.0	-17.7
2025	.0	21.4	21.4	7.0	10.0	20.8	37.3	.0	-16.4
2026	.0	21.4	21.4	7.0	9.5	23.1	35.6	.0	-18.2
2027	.0	21.4	21.4	7.0	8.8	26.7	42.5	.0	-21.1
2028	.0	21.4	21.4	7.0	7.7	31.0	45.8	.0	-24.4
2029	.0	21.4	21.4	7.0	6.3	37.9	51.2	.0	-29.8
2030	.0	21.4	21.4	7.0	3.5	41.4	51.9	.0	-30.5
TOTAL	.0	763.0	768.0	218.3	385.4	561.1	1164.8	.0	-396.8
AVG	.0	14.5	14.5	4.1	7.3	10.6	22.0	.0	-7.5
\$/KG	.0	7.3	7.3	2.1	3.7	5.4	11.1	.0	-3.8

Figure 7.3-7d Profit and Loss Report for
Permanent Storage Through 2030

-- Geologic Concept --

7.4 PROJECT FUNDING REQUIREMENTS

The project decision points shown in Figure 7.4-1 are the key control points for funding. At each point a commitment is made for a specific task of work and for a specific funds expenditures. During the early phases of the program there will be more uncertainty than in later phases. Consequently, the early decision points involve smaller funds commitments, thus allowing the uncertainties to be worked out prior to the larger funds commitments as follows:

- a) Decision to Initiate Study: The U.S. government's decision to initiate the GSFLS study was a commitment to undertake the tasks of preliminarily determining needs, assessing alternatives, and selecting preferred concepts.
- b) Expression of Interest: Expressions of interest by appropriate European Regional countries and the U.S. is the next necessary decision. These decisions represent only that the GSFLS study results have been reviewed with the conclusion that a regimed fuel cycle center concept such as the ERSFLS may be beneficial to all countries concerned. No additional commitment of funds would be required, but participating countries would agree to work toward the definition of the effort to be done during the formulation phase.
- c) Decision to Form the Project: This decision would follow the definition and acceptance of the work statement and schedule for the formulation phase. It is estimated that this phase would involve an expenditure of 2 to 4 million dollars over the year and a half period and would require some

Figure 7.4-1: Project Schedule

organizational structure dedicated to the project. As this is the formulation period it might be desirable for formulation funds to be committed at 6 month intervals. This would provide additional decision points to assure that the program progresses in this critical period to the satisfaction of participating governments.

- d) Decision to Acquire AFR Capability: This decision is made after the formulation phase has resulted in a specific set of international agreements, establishment of the ERE entity, establishment of the regulatory and control mechanisms, and definition of the specifications and preliminary design of the ERSFLS. The commitment would include contracts with suitable engineering and construction organizations. The commitment is for a \$400 million capital program through 1985, however a significant portion of this would be borrowed funds. The equity portion, or new capital required, would be about \$75 million by 1985.
- e) Decision to Expand the AFR Capability: The initial AFR capability would include a single water basin. Additional water basins would be required as the demand increases. The estimated construction schedule would provide 16 additional basins constructed between 1985 and 2000. Also required are additional ships and casks. Funds for these capital projects would be committed as the need arises.

Each decision would be based upon an assurance of the market, confidence in the pricing mechanism, and expectation of expedient licensing. These expenditures would be of relatively low risk. The total commitment for AFR expansion to 2000 is expected to be about \$650 million. However, this

commitment would come from borrowing and from the ERE's cash flow. No outside equity capital would be required.

f) Decision to Acquire Recovery Capability: The business decision to acquire recovery capability necessarily follows the political decision on the acceptability of recovery processes in terms of the non-proliferation objectives. The preferred concept considers the case where these decisions are affirmative and recovery operation begins in 2000. The decision to acquire this capability represents a commitment of expenditures of approximately \$2.8 billion. The deferral of the decision to 1990, while being included as a non-proliferation consideration, has several beneficial effects in terms of the funding decision. These include:

- 1) Technology should improve in the 10 to 15 year deferral period.
- 2) Licensing should be less uncertain. This is due to better developed regulations, development of a working relationship between the ERE and its regulatory agency, and the resolution of present non-proliferation concerns.
- 3) Funding should be easier to obtain. At the decision point the ERE will have been in operation for 5 years and is estimated to be in a profitable position. The cash flow of the ERE during the construction period from 1990 to 2000 should be sufficient to provide the required equity capital. If recovery were initiated at the beginning of the project additional equity capital would be required.

- 4) The value of the recovered products should be higher due to increased scarcity of the raw material.
- g) Decision to Acquire Permanent Storage Capability: This decision may be made following the decision on whether or not to recover useful products from the spent fuel. The deferral period should allow data to be developed as to whether geologic repositories or air cooled vaults will be used and whether or not the facilities should be co-located with the ERSFSL. The preferred concept considers use of geologic repositories. A total commitment of about \$560 million would be required.

Figure 7.4-2 shows the buildup of funds commitment in relation to the major project decisions.

Figure 7.4-2: Buildup of Total Project Funds Commitments

APPENDIX A - Candidate Models for a Pacific Basin Arrangement

The principal features of the candidate models and their possible major inputs to the development of a Pacific Basin concept follow, in the following order: (1) EURATOM, (2) URENCO and (3) SAS.

1. EURATOM as a Candidate Model

EURATOM.1 Principal Features

General Background

The energy policy of the European Community has been slow to develop, partly because the Community treaties split up responsibilities for energy. The European Coal and Steel Community (ECSC) covered coal and coke; the Euratom Treaty, nuclear energy, and the European Economic Community (EEC) natural gas and petroleum. The merger of the three communities into the European Community in 1967 ended this inconvenience by creating a single Commission and a single Council of Ministers, which are the two executive institutions of the Community.

The Commission is a permanent body, exclusively devoted to the realization of the missions of the Community, and represents the constant expression of the single general interest of the Community. The Council constitutes a forum where open exchanges of views can take place between the competent members of the governments on the various problems facing the Community.

The Commission is consulted by the Council before the latter takes a stand. This preliminary consultation, always possible upon the initiative of the Council, is sometimes made obligatory by the Treaty. In the case of important decisions, the Council cannot take a stand except upon a proposal of the Commission. In this setting, the Euratom Treaty constitutes a multinational charter which empowers the Commission and the

Council to pass laws and carry out policies covering the entire nuclear fuel cycle and its related technologies. The Community uses three types of legal instruments which apply to the Euratom Treaty:

- o Regulations bind the member states directly and have the same strength as national laws;
- o Directives also bind the member states but allow them to choose the means of execution; and
- o Decisions, addressed to a government, an enterprise or an individual, bind the parties named.

The Commission and the Council also render non-binding recommendations and opinions.

In accordance with the Euratom Treaty, an administrative organization for nuclear energy was launched, and activities to develop a nuclear common market are pursued.

The Community's Organization for Nuclear Energy

The Commission administers the Community's specialized agencies and operations for nuclear energy; controls the implementation of nuclear policy options; and drafts policy proposals for the Council. The Council, in turn, selects nuclear policy options, defines the priority programs in the field and allocates the appropriate budget to the Commission (Figure 1).

The Treaty entitles the Commission to set up specialized agencies to promote the development of nuclear research, provide adequate uranium supplies to the Community and ensure adequate control over the utilization of nuclear fuels. The Joint Nuclear Research Center (JRC) at Brussels, Belgium leads and coordinates the research efforts for the Commission (Figure 1). The JRC controls four establishments:

FIGURE I

The Community's Principal Institutions for Nuclear Energy

- o The Central Bureau for Nuclear Measurements (CBNM), at Geel, Belgium;
- o The Institute for Transuranium Elements (ITE), at Karlsruhe, Germany;
- o The JRC - Ispra Operation, heavy water reactor development, at Ispra, Italy; and
- o The JRC - Petten Operation, high flux reactor development, at Petten, the Netherlands.

The mission of EURATOM in relation to materials is entrusted, in the first instance, to the Commission and through it to a special agency which is provided for in the Treaty. EURATOM's Supply Agency (ESA) is to play a central part in commercial operations involving ores and nuclear materials in the Community. Enjoying legal personality and financial autonomy, ESA is to be administered like a business in conformity with a charter adopted by the Council, voting by a prescribed majority, on a proposal submitted by the Commission (Figure 1).

The observance of strict safety rules for each member of the Community is imperative. The EURATOM Safeguards Department (ESD) located in Luxembourg has 115 staff members of whom 60 are safeguard inspectors, drawn from all nine Member States. They are permanent European civil servants and are therefore responsible towards the Commission and not towards their country of origin (Figure 1).

Finally, a general administrative body, the Nuclear Division, under the General Directorate for Energy Affairs in Brussels, administers the various research programs and joint enterprises launched by the Community (Figure 1).

The Community's Activities in Nuclear Energy

The Community's activities in the field of nuclear

energy can be grouped into four basic areas: research and industrial development, health and safety, and the supply and control of nuclear materials.

Research and Industrial Development

The Commission's activities for developing research and supporting initiative concerning industrial equipment are essentially aimed at consolidating a nuclear common market. As such, the information dissemination and patents policy, educational programs, investment advice programs and joint enterprise procedures are all set to foster an integrated, free market situation between the member states.

Customs duties common to all member states are applicable to imports from outside countries on most nuclear goods and products. No restriction based on nationality may be applied by the Commission to individuals of member states seeking either specialized employment in the nuclear field or participation in the construction of nuclear plants being built for scientific or industrial purposes. Necessary measures are taken to facilitate the conclusion of insurance contracts against atomic risks. Currency restrictions between the member states are abolished in a manner commensurate with the freedom of movement extended to goods, services, capital and persons.

These measures, which are intended to facilitate the pooling of the human and material resources of the Community, are for the most part left in the hands of the member states. In matters pertaining to customs duties, these states are bound to respect a certain calendar. In other fields, they are subjected to pressure to be exerted by the Commission. At times,

the Commission may send recommendations to the member states or otherwise make sure that they fulfill their obligations. At other times, the Council, voting with a prescribed majority on a proposal set forth by the Commission, may address to the member states directives which firmly commit them to reach certain objectives.

Health and Safety

The Treaty lays upon the Commission the task of protecting man against the risks inherent in the use of nuclear energy. Accordingly, the Commission conducts research on radiation protection, lays down radiation protection standards, undertakes the study and prevention of contamination due to waste from nuclear installations and organizes the monitoring of background radioactivity levels.

Each member state is to take whatever steps are necessary to ensure the observance of minimum standards. The Commission, which is to be informed on measures taken to this effect and on contemplated measures is expected to make recommendations to harmonize such measures. Should a member state propose to conduct particularly dangerous experiments, it must first consult the Commission on additional health precautions to be taken. The approval of the Commission is required concerning these precautions if the experiments are likely to affect the territory of other member states.

Each member state is to establish on its territory the installations necessary for control. The Commission is to have access to such installations. The Commission is also to be kept informed on all plans to dispose of radioactive waste, and the Commission, in turn, will in its discretion communicate to the

member states views and recommendations which it deems pertinent. In an emergency, it may issue a directive with which the member state will be bound to comply, within a time fixed by the Commission; should the government fail to comply, the Commission can bring the matter immediately before the Court of Justice.

Supply of Nuclear Material

Ores, raw materials and special fissile materials are defined in the Treaty and can be adapted to scientific and technical evolution by the Council, voting by a prescribed majority, on a proposal submitted by the Commission. These materials are unequally divided among the member states. Centralization of trade as regards all nuclear industries of the Community gives the ESA a strong position in the world market, makes possible a joint supply policy and ensures equal access of all the industries of the Community to the resources thus pooled. The Supply Agency's activities are supported by two fundamental rights: a right of option over the ores and nuclear materials produced in the Community, and the exclusive right to conclude contracts for the supply of ores and nuclear materials originating from within the Community or from without.

All producers of the Community are required to offer the Agency the ores or nuclear materials they produce in the territories of the member states. However, the producer who on his own or with other enterprises linked with him processes materials through several stages of production, from the extraction of the ore up to and including the production of the final metal, may offer his products to the Agency at any of the stages of production he chooses. The only condition is that the producer who wishes to take advantage of

this privilege must keep the Commission fully informed of his activities and arrangements.

ESA is to exercise its right of option by concluding contracts with the producers. If it does not exercise its option, the producer may process his product and offer it afterwards to ESA. He may also be authorized, by decision of the Commission, to export his product on terms which must not be more favorable than those he offered to the Agency.

Thus assured of the power to conclude contracts for the supply of products available inside and outside the Community, the Agency periodically collects information on all offers and detailed supply requirements of ores and nuclear materials. ESA makes known to all potential users the conditions under which it can fulfill the needs of users and producers. In case the Agency is unable to fulfill orders completely, it is to allocate available supplies in proportion as orders are received.

The interplay of supply and demand through the Agency is expected freely to determine prices. However, the Agency may put forward to users proposals for the equalization of prices. An arbitrary fixing of prices can only be decided by the Council, voting unanimously on a proposal submitted by the Commission.

In all its activities, the Agency is bound to respect and to enforce respect for the principle of equal access. The Agency is not authorized to alter the users' orders, except for the origin of imported products and for quantities delivered, when demand exceeds supply. Users are bound to act through the medium of the Agency, but they are free to set their own requirements and the terms of their orders. They

will be able to make an informed choice because the Agency is required to inform them on all offers of available products it has been able to collect. Although regulated and centralized, the exchange of ores and nuclear materials remains essentially in the hands of producers and of users.

Control of Nuclear Material

EURATOM safeguards apply not only to all civil nuclear materials in the Community but also to equipment and non-nuclear materials for use in nuclear installations supplied by separate agreements with third countries, if such agreements so require.

Every undertaking in the Community which handles fissile materials for peaceful purposes must notify the Commission of the plans and capacity of its installations, the nature of the materials used and produced, the technical processes applied and the methods used to measure and check the quantity and quality of the material held in the plant. It must also give particulars of movements of stocks, the sources of its purchases and the destination of its sales.

Installations are inspected on two levels - accounting and technical. First, the inspectors call for the accounts of materials held by the undertaking and the documents from its suppliers and transporters; they then draw up an accounting "inventory" of the materials stored in the plant and check this against the statement made to the Commission. They also verify that the basic characteristics of the installation conform with those declared to the Commission and check that the materials and finished products correspond to the uses as declared.

If a violation is verified, the Commission can issue a directive enjoining the member state in question

to take within a prescribed period all measures necessary to put an end to the violation, after which period the Commission must promptly bring the matter before the Court of Justice. The Commission may also impose direct penalties against persons and enterprises guilty of infringements. These penalties can include the withdrawal of special advantages, either technical or financial, the placing of the firm under a provisional administration for a maximum period of four months, or even the withdrawal of nuclear materials.

Exercise of these powers is limited to the pursuance of the three objectives of control. The first concerns the application of supply regulations which have already been described.

The second seeks to prevent diversion of ores and nuclear materials from their intended use as stated by the users. This formula implies a free determination of the ultimate destination of the product, which determination the Treaty itself does not limit in any other way. Military uses as such are not forbidden by the EURATOM Treaty. The Treaty is content to stipulate that control is not to extend to material intended for the purposes of defense that is being specially processed for such purposes, or which after being processed, is, in accordance with an operational plan, deposited or stocked in a military establishment. But once they have acquired a military character, these materials are subject to armaments controls. Where the control of the EURATOM Treaty ceases to operate, other international organisms are expected to begin functioning. Moreover, even nuclear materials intended from the beginning for military purposes are

submitted to the ordinary rules of supply, i.e., have to pass through ESA.

The third objective of control by EURATOM is to ensure the observance of all special agreements relating to control between the Community and an outside state, or with an international organization.

In April 1973, the Community and the IAEA signed a safeguards agreement pursuant to the Treaty on the Non-Proliferation of Nuclear Weapons. Under this Agreement, the inventory of nuclear materials in the signatory member states as of the 28th February 1977 has been transmitted to IAEA, which is now regularly informed of all nuclear material stocks and movements into and out of installations in these states. Many inspections by IAEA for verification of the initial inventory and for design information verification have been carried out since then at the same time as EURATOM inspections are being performed. Studies are being made based on the knowledge and experience of EURATOM in applying safeguards at their facilities to determine the optimum techniques and procedures for future routine application.

EURATOM.2 Major Inputs to Pacific Basin Concept Development

The EURATOM Treaty is obviously a very ambitious arrangement covering the entire nuclear fuel cycle with an aim to establish a nuclear common market, coordinate nuclear R&D in Europe and launch a full-fledged nuclear industry. It also presupposes a constitutional type of international agreement, which is well beyond the scope of the Pacific Basin concept now under investigation.

EURATOM's institutional arrangement can, however, provide unique organizational features for a Pacific concept

development on two counts. The Treaty provides (1) a unique institutional model with EURATOM's supply agency (ESA) to help in the development of pertinent business operations features; and (2) well-proven vehicles with the Joint Enterprise (JE) and Investment Advice (IA) concepts for exploring adequate modes of activity development.

ESA's Major Inputs to Concept Development

ESA's two fundamental rights (the right of option over uranium ore and nuclear materials, and the exclusive right to conclude contracts), provides an appropriate framework for a multi-national spent fuel storage venture. Such rights can easily be translated for a spent fuel environment, and would provide an AFR facility with exclusive rights of option over spent fuel materials and of concluding contracts with producers and parties outside the convention. Accordingly, all customers of the AFR facility would be required to offer all their generated spent fuel to the facility and would have the possibility to do so at any stage of the fuel production cycle (i.e., prior and/or after reprocessing, in the event that reprocessing activities would be carried out in the future).

In the case the Pacific Basin arrangement could not satisfy its orders for services, either in whole or in part, within a reasonable period, or only at uncompetitive prices, a mechanism exists authorizing users to make direct contracts with third parties, provided that the consortium is notified of such decisions, and that the presumably existing control board of the consortium would have given its approval. The control board could always oppose such a contract if it thought it would be contrary to the Treaty. This safety valve would give the users a basis for

checking the quality and competitiveness of the services provided by the consortium, subject to approval of the control board. It provides a practical guarantee against any monopolistic abuse on the part of the consortium.

ESA's operating framework also sets a well delineated pattern concerning fuel ownership and title. Fissile materials, either produced or imported are the property of EURATOM, ESA being the managing agent.* Although this transfer of ownership to the international level is not compatible with business operations criteria for the Pacific, EURATOM's organization still remains a valid model; ESA's operating framework could still be as effective with spent fuel titles remaining in the hands of national parties. As a matter of fact, ownership by EURATOM leaves the user with the fullest rights to use and consume the fuels, subject to the obligations imposed on him by the provisions of the Treaty.

As a result of this system, a special financial arrangement has been set up. On behalf of the Community, ESA keeps a current account between EURATOM on the one hand, and all the users on the other, ESA acting as a user. Balances are payable immediately on request of the creditor. This system was found efficient in reducing operating complications to a minimum, while maintaining a special right to EURATOM. In a Pacific Basin context, the cession of spent fuel to a Pacific consortium could still be possible, the AFR facility acting as a user for the consortium.

* There are only two exceptions: the case of special fissile materials having a military character, or which are temporarily imported into the Community for a given project, and then returned to the sender.

The accounting procedure placing the AFR facility as a user would have many advantages. First, in an interim spent fuel storage context, maximum flexibility would be gained for spent fuel movement and retrieval with no financial accountability problems for the operating subsidiary. As a user, the subsidiary would lease its property assets (the spent fuel reserves) from the consortium (the caretaker), avoiding the risk and responsibility of independent property assets valuation "against" the other users. The risk associated with property assets valuation should not be minimized, considering the present uncertainty surrounding back-end fuel cycle configurations and the great economic interdependence among activities in the back-end of this cycle (e.g., the profitability of interim storage depends on the decision made about reprocessing). A lease-type arrangement would provide for the owner (1) a guarantee for stability in the valuation of its property assets and (2) a good bridge to expand its activities to other areas (including reprocessing if need ever occurs) through new leasing arrangements, without jeopardizing the financial existence of the company.

Second, from a reprocessing deferral standpoint, the leasing mechanism may be a very useful concept for implementing U.S. objectives in the Pacific Basin. A lease-type arrangement could effectively circumvent the problem of spent fuel valuation (by which the value of reprocessing would be recognized) by leasing the spent fuel to the operating AFR facility for a nominal fee pending the decision to reprocess or forego reprocessing.

Third, placing the subsidiary in a user position would provide great flexibility for the future expansion and diversification of the consortium into other

activities. The consortium would be free to choose between the launching of new subsidiaries or diversifying the activities of existing enterprises, while relying on a normalized, yet activity-specific accounting format without the risk of going through the process of liquidation(s).

In such a context, the executive board of the consortium (the Advisory Committee in ESA's statutes) would essentially have two basic functions (1) ensure to the extent possible economic stability conditions and viable economic transitions for its subsidiaries as new developments in the back-end of the fuel cycle emerge; and (2) facilitate the surveillance mission of an independent "inspectorate" in charge of safety, safeguardability or audit activities.

The Joint Enterprise (JE) and Investment Advice's (IA)
Major Inputs to Concept Development

The EURATOM arrangement provides well-proven vehicles for exploring adequate modes of activity development with the Joint Enterprise (JE) and Investment Advice (IA) concepts.

In a Pacific Basin context, JE arrangements would help private initiative launching activities for the consortium that would require the commitment of sizeable front-end resources, or at a speed that an individual entrepreneur could not carry alone. The JE vehicle would permit flexible arrangements between the consortium and the private sector for such activities, and would give the entrepreneur legal personality within the consortium with the widest recognized rights in each of the countries involved in the consortium.

With an Investment Advice (IA) practice, a Pacific Basin venture would help new facilities in projecting their investment requirements by disseminating

information about projected service needs, as assessed by the various countries participating in the consortium, or by third-party countries that would approach the consortium for services.

2. URENCO as a Candidate Model

URENCO.1 Principal Features

General Background

The signing of the Treaty of Almelo in 1970 marks the conception of URENCO, a tripartite uranium enrichment organization. The three Contracting Parties are the United Kingdom, the Federal Republic of Germany and the Netherlands. They have agreed to collaborate with one another, with a view to the enrichment of uranium by the gas centrifuge process and to the manufacture of gas centrifuge to that end. They promote the establishment and operation of joint industrial enterprises to build plants for the enrichment of uranium by the gas centrifuge process and to operate such plants and otherwise exploit that process on a commercial basis. Each of the Contracting Parties or commercial entities nominated by it have the right to participate equally in the joint industrial enterprises of URENCO. Finally, the three countries integrate their research in order to achieve and maintain a competitive position in relation to other sources of enriched uranium.

Organizational Structure of URENCO

URENCO is equally owned, one-third each by the three Contracting Parties through four organizations, URANIT (Uran-Isotopentrennungs Gesellschaft mbH), BNFL (British Nuclear Fuels, Ltd.), UCN (Ultra-Centrifuge Nederland N.V.) and GNV (Gesellschaft fur Nukleare Verahrenstechnik mbH). Exhibit - 1 presents URENCO's organizational and financial structure comprising the above companies and the percentage of their controlling stock. Uranit (FRG) is made up of private companies only; BNFL (UK) is entirely owned by the United Kingdom Energy Authority, thus is government-controlled. UCN (The Netherlands) is a combination of public and private companies. Staat der Nederlanden Reactor Centrum

EXHIBIT 1
URENCO/CENTEC: Basic Organization

A-18

Nederland and Staatsmijnen are government companies while those remaining are private. GNV (FRG) ownership is divided equally between two private companies.

The Joint Committee is an additional component of the URENCO structure. Each of the three nations (contracting parties) sends an accredited representative and accompanying advisors to participate in the Committee. Each representative has to vote.

Organizational Responsibilities of URENCO

For the purpose of collaboration, the URENCO Shareholders have formed two companies, Urenco Limited and Centec GmbH and two Enterprises, URENCO U.K. and URENCO NEDERLAND. Provision has also been made for the future establishment of possible third Enterprise in Germany. Exhibit -2 presents the functional structure of Urenco.

URENCO U.K. is managed by BNFL, UCN and URANIT as is URENCO NEDERLAND. The purpose of these two Enterprises is to manage the design, construction, ownership and operation of uranium enrichment centrifuge plants.

The two companies Urenco Ltd. and Centec take responsibility for numerous activities on behalf of the Shareholders and Enterprises, particularly international marketing and the licensing of technology.

As the agent for the Enterprises, Urenco Ltd. provides a central marketing service, schedules their product deliveries, and plans to represent the organization in joint ventures with third parties in the centrifuge enrichment field.

Centec's duties are threefold. It coordinates the joint tripartite R&D program and the information exchange between the Shareholders, is in charge of an overall portfolio of centrifuge technology and patents, and represents the organization in transactions with third parties regarding the sale or licensing of technology, or of enrichment plant and equipment.

EXHIBIT 2

Distribution of Functions in the URENCO Arrangement

Finally, the purpose of the Joint Committee is to:

- o consider and decide upon any questions concerning the safeguards
- o consider and decide upon questions arising out of the classification arrangements and security procedures
- o advise the Contracting Parties as to the conditions upon which any agreement with other States or international organizations consider and decide upon any proposals for:
 - the transfer outside the territories of the Contracting Parties of information derived as a result of collaboration
 - in granting of licenses or sub-licenses for the territories of the Contracting Parties
 - the export outside the territories of the Contracting Parties of equipment or materials developed, produced or processed under the collaboration
- o approve the instruments establishing the joint industrial enterprises
- o approve proposals of the joint industrial enterprises for the siting of major installations
- o make arrangements for the assessment and payment of royalties in regard to patents and other industrial rights
- o approve such research and development programs as they are to be financed in whole or in part by joint Government grants of the Contracting Parties, and consider any proposals from the joint industrial enterprises for varying the proportion of the cost of research and development to be borne jointly by the Contracting Parties
- o decide upon or recommend to the Contracting Parties appropriate measures to be taken if technical or economic developments occur which are likely to affect significantly the commercial exploitation of the gas centrifuge process by the joint industrial enterprises

URENCO.2 Major Inputs to Pacific Basin Concept Development

URENCO's major contribution to the development of a Pacific Basin consortium is twofold: (1) the model provides a simple, well delineated distribution of functions within the consortium, separating safeguardability functions from business operations functions; and (2) the model illustrates the institutional alternatives existing when a clear distinction is made between national and international levels in formulating participation strategies.

First, URENCO represents a multi-national arrangement, meaning a much smaller number of participants, or groups of countries (as opposed to international arrangements), which provides a simple distribution of functions.

A multinational organization with a well delineated separation of functions may particularly improve its non-proliferation effectiveness while achieving operational and technical proficiency. URENCO exemplifies this situation as being a successfully operated multinational business venture, and thus a good reference for a Pacific Basin consortium.

URENCO's separation of functions is of particular interest for the development of a Pacific Basin consortium. The main objective of the Joint Committee, which meets with company management, is to provide timely guidance to the otherwise autonomous venture management on commercial, production, and RD&D policy matters that could give rise to problems of a political nature, and is designed to facilitate proper coordination of industrial activity and political interest. The managing partner, URENCO Ltd. has an executive board on which there is representation of the three participating countries. This unit functions largely as a marketing and production management overseer with the aim of promoting growth on a sound basis in accord with a common commercial policy. With such a structure, it is possible that the inevitable differences of viewpoint that arise may get sorted out constructively through URENCO's executive board, and

thereby hold to the minimum, the need to seek solutions in the political-level body (the Joint Committee). Likewise, RD&D and patent/licensing strategy options are selected at the Centec GmbH level before reaching the URENCO executive board for final decision.

At this point, it should be emphasized that such a decision making process is made possible by the small number of participants. This does not imply that a Pacific Basin consortium should limit its entries for participation, but rather a grouping or merging of interests and representation should occur at the multinational level for the partnership structure. A possible combination would include the US, Japan, and a conglomerate of the Republic of China (ROC), the Republic of Korea (ROK), and the Philippines. In addition, URENCO does not limit its supply of services to its three investor/owners only: Additional customers are actively sought. The same could be true in a Pacific Basin consortium whereby the US, Japan and the conglomerate would store their own fuel, but also expand their interests to accommodating the fuel of other customer countries.

Second, URENCO applies a different ruling for developing participation structures at the multinational and national levels. At the multinational level, a strictly equal partnership situation prevails. In the Joint Committee, each sponsoring government has equal representation. Committee decisions must be unanimous. (There are, of course, only three interests to be represented, and each has the same financial stake). Similarly, the URENCO executive board has a three tier representation of the three participating countries, but is not held by the rule of unanimity. Without advocating URENCO's strict equality rule for a Pacific Basin, multinational consortium, it is possible to envision a situation where a reasonable balance could be achieved. A possibility would be to give the US 40%, Japan 40%, and the conglomerate 20%. At this time, such percentages are given for illustration purposes only.

At the national level, however, maximum freedom for structuring one's participation is allowed. The units of the URENCO consortium present all the possible combinations of cross-tie arrangements between national parties as well as distinct commitment levels on the part of the national governments. All the possible status alternatives exist: private ownership, public ownership, and hybrid (private-public) ownership. Thus, URENCO is partly funded by two governments (UK and the Netherlands), while FRG's participation is totally private.

In the URENCO structure, the use of governmental and non-governmental entities is not a mutually exclusive choice both at the multinational and national levels. Such an approach to the development of a Pacific Basin consortium would ensure a maximum number of participations, and thereby chances of success.

3. SAS as a Candidate Model

SAS.1 Principal Features

General Background

The Scandinavian Airlines System (SAS) consortium is founded on two constituents, the SAS Concessions and the Consortium Agreement. Of the first, the respective governments have granted the three parent companies, DDL (Danish airlines), DNL (Norwegian airlines) and ABA (Swedish airlines) Concessions which in turn form the basis for SAS. Primarily, the Concessions standardize the legal/regulatory framework of the parent companies by extending their individual rules to each other. In addition, provisions limit the activities of each company which might conflict with current or future international agreements signed by the three countries.

Second, the Consortium Agreement defines the operating conditions for SAS. Multi-national agreement places the consortium in a private venture situation to be managed according to standard business rules. It delineates general management principles and responsibilities in such areas as: third party liability, business allocations among partners, equity contributions for capital formation, distribution of benefits, the decision-making structure (Board of Directors), and the management control procedures (Assembly of Representatives, Board of Representatives, Accounts and Audit procedures). Finally, the document identifies solutions for typical situations such as the withdrawal of parties from the consortium, liquidation, and arbitration.

Together, these SAS constituents have created an efficient and flexible working environment for the multi-national consortium by meeting the above requisite business criteria. As a result, SAS has grown markedly in thirty years, expanding its initial airline transport activity to now include hotels, restaurants, catering, inclusive tours, car rentals,

convention arrangements, and other related services. About fifty companies are totally or partially owned by SAS. Close to half of these subsidiaries and associated companies are active; the rest may be holding companies, real estate companies, or simply registered names that are dormant for the time being.

The effectiveness of the SAS Consortium is characterized by three major institutional features which facilitate private/public joint international ventures:

- 1) an effective managerial framework
- 2) a simple financial structure
- 3) a flexible partnership arrangement

Organization and Management of the Consortium

Borrowing from the organizational pattern of private corporations, SAS is managed by an Assembly of Representatives, a Board of Representatives, a Board of Directors, and a President, assisted by several managers. The control function is mainly performed by auditors appointed by the Assembly of Representatives; the latter is responsible for accepting the results of the audits (Exhibit 1).

The Assembly of Representatives consists of the members of the boards of the three parent companies (ABA, DDL, and DNL). No more than eight representatives from each party, however, may take part as voting members (Exhibit 1). A quorum is formed with at least five members present from each of the parties. Each voting member is entitled to one vote only when present at Assembly meetings. A decision is agreed upon either by a majority of those voting, or if the voting is equal, by the opinion of the Chairman.

The Assembly of Representatives normally meets twice a year; extra sessions can be planned when the Board of Directors, the Auditors, or four members of the Assembly so desire. A notice for convening the meetings, specifying business to be

EXHIBIT I
THE MANAGEMENT ORGANIZATION OF SAS

dealt with, is sent to the members. The Assembly has numerous responsibilities:

- o Elect Chairman, Vice Chairman and Deputies
- o Annually appoint members to the Board of Directors; appoint their Deputies
- o Approve the report presented by the Board of Directors for each fiscal year on the management of Consortium business
- o Approve the yearly accounts and audits of the Consortium as prepared by the Auditors
- o Define the rules of authority for the Board of Directors
- o Discharge from liability as against the Assembly to the Members of the Board for the period covered by the annual reports
- o Decide on any matter referred to the Assembly by the Board of Directors
- o Decide on any matter referred to the Assembly by four members of the Assembly
- o Review periodical statements of accounts, reports and forecasts concerning ongoing and future activities

The Consortium's Board of Directors consists of six members with six deputies appointed by the Assembly; the Contracting Parties propose two members and two deputies (Exhibit 1). The SAS Board of Directors has the same authorities and duties as a board normally has in a corporation. A quorum is formed with at least four members present representing each of the parties. If the Board is not complete, a valid decision can be reached only if at least three members present agree. In such a case, a decision may not be made against the wish to any member present in a matter which was not indicated in the Notice of the meeting.

Finally, the accounts of the Consortium are audited by six auditors (Exhibit 1). Contracting Parties appoint two of these auditors and a deputy for each from the auditors and deputies who have been elected at that party's General Shareholders' Meeting. The auditors appoint a Chairman

among themselves for one year; he alternates among the Contracting Parties.

The Financial Structure of SAS

The three parent companies are owned 50 percent by private shareholders, and 50 percent by their respective national governments. In turn, the capital shares for the equity financing of the Consortium are 3/7 for ABA (Sweden) and 2/7 each for DDL (Denmark) and DNL (Norway) (Exhibit 2). The assets and liabilities assigned and taken over by the the Consortium include:

- o All properties, rights and liabilities jointly incurred by the parties (Exhibit 2)
- o All property owned, and other physical assets (i.e., aircrafts, buildings, other equipment, etc.) which the parties own individually, except real estate located in the three countries, and other assets agreed upon by the parties;
- o Specific liabilities, agreed to by the parties on a case-by-case basis, for which any of the Contracting Parties is responsible; and
- o Cash funds needed by the Consortium to satisfy the requirements of respective equity shares and/or for new, needed capital.

A cash payment clearing mechanism is instituted among the parties so that the contributions made by the Parties (valued as agreed upon among the Parties) will become adjusted to the shares defined in the international agreement.

One of the most important financial features is that the ownership of assets and property assets remains in the hands of the parent companies, and is therefore retained at the national level (Exhibit 2). According to the Consortium Agreement with regard to third parties, however, the Consortium can exercise ownership rights pertaining to the control, use, lease and disposal of assets. Specifically, according to the terms of the Consortium Agreement:

EXHIBIT 2
THE FINANCIAL STRUCTURE OF SAS

* Ownership of assets, and property assets remains at level 1

** Representative of FY 1976

'...all the assets and property assets shall internally among the parties be reported as owned by the Consortium, which... shall, with regard to third parties, exercise any and all the powers appertaining to ownership... including - without limiting the generality hereof - the power to control, use,... and lease, as well as to dispose of same by sale or otherwise'

From a partnership standpoint, this disposal allows maximum flexibility and simplicity of transactions in eliminating all the complex procedures of international title and ownership transfers to and from the Consortium. In the case of a withdrawal from one of the parties, the assets at stake are to be estimated at a value that would result from a normal and properly carried out liquidation of the group at the time of withdrawal.

All financial decisions at the Consortium level are made in accordance with sound business principles, eliminating provisions or exemptions for the application of such principles to particular activities on the basis of public management requirements or other administrative criteria. Distribution of benefits, payments on account to the parties, and future contributions are likewise governed by the rule of private business practice.

The Partnership Framework of the Consortium

The partnership framework of the Consortium is based on the transfer of rights, arbitration, the withdrawal of one of the parties, and liquidation. First, none of the parties can transfer, wholly or partly its rights or obligations without the other parties' consent. Each of the parties can, however, for the purpose of its own financing, pledge its rights as security provided that such an arrangement will not affect its obligations or the rights of the other parties in any way.

Second, any disputes regarding the interpretation or application of the Consortium Agreement cannot be made the subject of a law suit, but is to be referred to arbitration

for final and conclusive decision. If the parties cannot agree on the appointment of one or several arbitrations to decide the dispute, an Arbitral Tribunal (composed of the Presidents of the High Justice Courts in the three countries) makes a decision. The Arbitral Tribunal would then elect its own Chairman and settle its own rules of procedure, including the question of which national legal rules could apply in the case. Finally, the Tribunal would see that the decision is executed in accordance with the losing party's national law.

The SAS Agreement specifies the circumstances under which the value of assets of the withdrawing party can be estimated at a normal and properly carried out liquidation. These include:

- o The failure of one of the parties to fulfill its obligations (unless failure is of minor importance)
- o A situation where the financial capability of one of the parties becomes so weakened that it burdens the joint liabilities of the group to third parties
- o A situation where one of the parties would not be willing to join a decision of the Consortium, or conversely to substantially reduce the field of its activities
- o A situation where a party withdraws due to circumstances beyond his control (i.e., government intervention, financial crises in the party's own country).

In other cases, the general rule of assets valuation still applies, but the estimated value of the assets of the Consortium cannot exceed the net value of the assets specified in the last approved balance sheet of the Consortium, unless the assets or liabilities are computed solely on the basis of current official quotations.

Should two of the parties request the withdrawal of the third one, the only eligible situation would be that due to

circumstances beyond the third partner's control. The third member would then be entitled to re-enter the Consortium at a later date when the circumstances which caused its withdrawal have ceased to prevail.

In the event the parties do not agree whether a member is obligated, or entitled, or should be requested to withdraw from the Consortium according to the provisions of the Agreement, the arbitration procedure would apply. The same arbitration channel would be used when a disagreement occurred about the valuation of the share of the net assets of the Consortium, or simply about the allocation of property in the settlement.

When the Consortium is liquidated for other reasons than those mentioned in the case of withdrawal, a final settlement can be made on the basis of the respective initial shares in the Consortium unless the parties agree on another allocation, or approve to sell the assets for joint account. An interesting feature is also provided by the Agreement for liquidation during the first five years of the Consortium. During this period, each of the parties have the right and obligation to receive all the physical assets which the party had contributed to the Consortium in connection with its formation. The assets thus received are to be estimated at the same value, minus the normal depreciation placed on them when they were contributed. Any litigation that occurs during and for the liquidation process of the Consortium would also be solved through the arbitration procedure set up by the Agreement.

SAS.2 Major Inputs to Pacific Basin Concept Development

SAS offers three important contributions to the development of a Pacific Basin concept: (1) a simple and efficient multinational organization which compares with that of URENCO; (2) a tailor-fitted arbitration mechanism for settling difficult partnership situations; and (3) an effective financial organization for a multinational group.

As in the case of URENCO, SAS provides a very efficient multinational framework. The major difference, of course, is that business operations are the only focus in SAS, whereas URENCO also addresses the safety and non-proliferation issues involved with the nuclear fuel cycle. Although no governmental representation can be recognized at the SAS corporate level, the SAS Board of Representatives could be compared to URENCO's Joint Committee, from the standpoint of the decision-making process. As a result, in both arrangements, two executive bodies exist at the corporate level: (1) A business operations head responsible for the daily management of the multinational venture with the SAS Board of Directors, and the URENCO Executive Board, respectively; and (2) An advisory committee for the timely guidance on general policy options with the SAS Board of Representatives and URENCO's Joint Committee, respectively.

In addition, the SAS framework provides interesting features with its independent Auditors body, and the institutional mechanisms set up to ensure equal representation, periodic reelection and chairmanship election and rotation in that body. Such institutional features will be particularly pertinent for a Pacific Basin consortium that will have to control two systems: (1) the standard business auditing and cost controls system, and (2) the spent fuel flow system with its attendant material balance areas (MBAs) and inventory change reports (ICRs) as suggested by EURATOM's international safeguards system.

As a second specific feature, SAS' arbitration mechanism may provide an appropriate institutional answer for a Pacific Basin consortium. Such an arbitration mechanism significantly reduces litigation difficulties such as determining a priori what is the applicable law(s) for the concern at the multi-national level. The question of applicable law is actually one of the most complex problems in international cooperation. With the SAS mechanism, the applicable law is selected on an ad hoc basis, and the interpretation and translation of national laws is also carried out by an ad hoc, permanent tribunal, which convenes whenever necessary. Such a jurisdictional mechanism has also the virtue to inevitably reach a final decision on a case, and to permit the treatment of sensitive issues (such as disagreements over the return of spent fuel to users) with a minimum of international visibility, and of external influences on the judicial process.

Finally, the financial organization of SAS can be of particular interest for the development of a multi-national spent fuel consortium, and its attendant problems of spent fuel ownership and title. In SAS, ownership of assets remains the province of the national parent companies. This option would comply with the requirements for operating an AFR facility in the Pacific Basin. But more importantly, the SAS Agreement makes a clear cut distinction between the ownership of assets (i.e. title) and the ownership rights that the consortium has when dealing with third parties. This distinction makes the SAS a very efficient, and flexible financial conglomerate. As previously mentioned, SAS now participates in, or oversees over more than 50 associate companies or fully owned enterprises.

According to the SAS financial framework, spent fuel would figure as 'spent fuel reserves' (a non-current asset category) in the consolidated balancesheet of the Pacific, multinational consortium. Depreciation of non-current assets (that would

include spent fuel) would also appear in the consolidated profit and loss statement of the consortium. Interestingly, this arrangement could be analyzed as an alternative to EURATOM's arrangement to put the (hypothetical) AFR facility in a user situation from an accounting perspective. Yet, a combination of both arrangement can also be envisioned. In that case, a Pacific Basin consortium would be launched, having for first priority to design, build and operate a wholly owned multinational AFR facility. The consolidated balancesheet and profit and loss statement of the consortium could then be strucutred the way the SAS financial documents are, while the AFR facility could be treated as a managing agent for the consortium, (i.e., a user of the spent fuel from an accounting standpoint, using EURATOM's approach). Appropriate leasing mechanisms could be developed for shaping the financial strucutre of the conglomerate, including the relationships among, (1) the consortium (i.e., the spent fuel care-taker), (2) the national parent companies (i.e., the spent fuel owners), and (3) the AFR facility (i.e., the multinational spent fuel user).

APPENDIX B:

Materials Accountability and Control Regime Considerations

1. Introduction

The formulation of an overall control regime for multilateral fuel cycle activities presents problems on which, at best, only limited experience has been accumulated. The appropriate allocation of responsibility among the international authority (i.e., the International Atomic Energy Agency) the multilateral consortium, and the host country involves consideration of both a political and technical nature. Moreover, the appropriate roles to be played by the various elements of the consortium itself - its political organ, its shareholders, and its management - pose difficult issues which at the same time both depend on and influence the structure of the multi-national institution.

The most relevant background and experience in facing these issues in the past has occurred in the European context, involving both the European Atomic Energy Community (EURATOM) and the European Nuclear Energy Agency (later the Nuclear Energy Agency) of the OECD. While the circumstances surrounding this experience were and remain quite different from the case of a consortium created for a special and limited purpose such as spent fuel storage, there are valuable lessons to be derived from the European regional experience, which is summarized in Section 8 of this Appendix.

As employed in this discussion, the term "control regime" is used in its broadest sense, encompassing:

- (1) the measures employed by:
 - o plant management
 - o the stockholders
 - o the member states of the consortium

- o the host country, and
 - o the International Community (i.e., the IAEA),
- to satisfy themselves of the location of and security of material entrusted to the consortium.
- (2) the responsibilities assigned to each of the above tiers for deciding, or participating in decisions, on the acceptance and release of material.
 - (3) the responsibilities, if any, of all of the above tiers in the protection of material destined for or transferred from the facilities of the consortium.

2. Discussion

A number of historical circumstances and current policy objectives affect the selection of an appropriate control regime for a possible spent fuel storage consortium serving the Pacific Basin. Among these are the following:

- (1) A global consensus exists that the primary responsibility for "safeguards", i.e., the verification that nuclear materials allocated to peaceful uses are not directed to nuclear explosives, appropriately lies with the International Atomic Energy Agency. This consensus, which is reflected in the Statute of the Agency, in the Non-Proliferation Treaty, and in the national policies and practices of both supplier and recipient nations, is not a historical accident. It reflects the conclusion that only an organization of global composition can provide universally credible assurances that diversion is not taking place. For these reasons, U.S. policy strongly supports the continued primacy of the IAEA's role in the application of safeguards.

- (2) The owners and operators of nuclear facilities or holders of nuclear material, as well as their national authorities, and, by extension, any regional authorities which they may create, also have legitimate interests in the control of nuclear materials under their supervision or jurisdiction. The IAEA safeguards system specifically recognizes and heavily depends upon the presence and adequacy of "local" materials accounting and control systems.
- (3) Proper delineation of responsibilities and roles, as experience has demonstrated, is essential to avoid conflicts which can adversely affect the effectiveness and credibility of the overall regime. As a general rule, the verification activities of each tier, no matter how technically effective, cannot provide a credible substitute for, and should not be interposed as a limiting factor upon, the verification activities deemed necessary by each higher tier of authority to meet its responsibilities for independent verification.
- (4) Independent verification, i.e., verification whose objective reliability and credibility do not, in the final analysis, depend upon the unilateral assertions or data of the inspected organizations, is the essential principle of a meaningful verification system. Subject to this overriding principle, full use of the data secured by lower tiers is desirable and, indeed, essential if the system is to be reasonably cost effective.
- (5) An effective regime of verification must be complemented by appropriate measures for the physical protection of nuclear material from subnational threats including diversion, seizure,

and sabotage. While the IAEA has played an advisory role in developing physical protection standards, it has no general authority to apply such measures to national or regional facilities. There is, however, no "conflict of interest" involved in the exercise by national authorities of physical protection against subnational threats, provided adequate technical competence and resources are available. Accordingly, national responsibility to provide protection against subnational threats has generally been accepted as appropriate, if accepted international standards of protection are met.

- (6) The current nonproliferation regime contains no provision for physical protection against national threats of diversion or seizure of material or facilities dedicated to peaceful uses, relying instead on the detection of such acts by the safeguard system and on the penalties which might flow from such detection.
- (7) The IAEA is, however, authorized to acquire and operate facilities on its own behalf under certain circumstances, and this authority is explicit with respect to storage of produced material. Authority for the Agency to provide physical protection for material present in facilities which it operates appears to be implicit, but there has yet been no case in which the Agency has exercised, or sought to exercise, this authority.
- (8) Similarly, no regional or multilateral authority has as yet taken primary responsibility for physical protection of materials, although multilateral organizations operating facilities (e.g., EUROCHEMIC) have assumed on-site protection responsibilities.

- (9) National policies, including that of the U.S., on the proper allocation of either verification or physical protection responsibilities in a multi-national regime have not, insofar as the Study Team is aware, been established.
- (10) Similarly, there is little background and experience concerning the response to violations or abrogations of nonproliferation undertakings, whether in the bilateral, multilateral or international sphere. In general, bilateral, multilateral (e.g., the EURATOM Treaty), and international instruments all prescribe somewhat similar penalties for proven violations: the suspension or termination of further nuclear material deliveries or other forms of nuclear assistance, and the right to require (without explicit means of enforcement) the return of previously supplied materials and equipment. The ineffectiveness of these remedies against deliberate and serious violations is self-evident. While the treatment of this area of control mechanisms - i.e., what might be broadly designated as sanctions - is beyond the scope of this study, it is apparent that sanctions or penalties involve an important part of the overall control regime for a multilateral fuel cycle which must be dealt with in the founding agreements.

3. Elements of the Control Regime

In addition to explicit control measures and systems, there are several more general features of a multi-national institution which have important implications for the overall control regime. Foremost among these is the composition of the institution itself. In order for the control measures of a

multinational institution to have "credibility," there must be genuine adversity of interest among its members, at least with respect to the fundamental issue of acquisition of nuclear weapons.

Credibility, moreover, is a subjective matter. It involves both credibility to the members of the organization itself, and credibility to outside nations. In the case of EURATOM, for example, the Member States were and are presumably satisfied that their own interests in avoiding the spread of nuclear weapons among themselves through abuse of peaceful nuclear activities is of sufficient strength that they can rely on the objectivity of their measures to verify end use. The Soviet Union, on the other hand, has expressed a reluctance to accept inspection by Community members of each other as a credible assurance against diversion.

It is not difficult to imagine other groups which, by their composition alone, would be unable to provide nonproliferation assurances which the United States would regard as credible. Institutions which include in their membership a nuclear weapons state have a particular claim to credibility, although there is no absolute need for nuclear weapons state participation if adversity of interest can be satisfied in other ways.

Credibility has a technical as well as a political component. In addition to adversity of interest, the technical capacity to undertake effective and credible control measures must be present if the nonproliferation assurances of a multinational group are to be accepted as reliable.

Siting or location is another feature which, while dependent on many considerations, has important control implications. Placement of the multi-national facilities in the territory of a secure, stable and reliable state provides considerable assurance against many conceivable diversion scenarios, even if control measures within the site itself are in the hands of the multi-national institution. Among candidate locations which would be particularly stable from the control standpoint are nuclear weapons states and neutral nations of unquestioned stability.

Finally, the nature of the activities to be undertaken by the multi-national institution is of obvious importance. Activities of low proliferation sensitivity such as spent fuel storage place less difficult demands on control measures than do such steps as reprocessing, but the potential for evolution in the activities of a regional fuel cycle institution makes it important to develop a control regime which is at least not inconsistent with the more stringent control requirements which might be imposed by future activities.

In the proposed organization developed in the previous section, the composition of the consortium would include the United States, Japan, and other Pacific Basin countries with nuclear power programs - currently, the Republic of China, the Republic of Korea and the Philippines. While the control "credibility" of a group of this composition naturally depends, among other considerations, on the specific organization structure and powers of each participants, the group clearly satisfies the minimum conditions of adversity of interest among its member nations.

The potential sites for the consortium facilities can be divided among U.S. locations, and non-U.S. Western Pacific locations. It is assumed that Japan is an improbable

site, on the basis of reservations on the part of Japan itself.

Siting considerations are discussed in fuller detail in Section 3.4(Part II). In general, however, it can be concluded that non-U.S. sites would possess less intrinsic nonproliferation credibility than would a U.S. site, both from the standpoint of the U.S. and third party countries. This lessened credibility would have to be overcome by strengthening other provisions of the control regime.

The initial activity of the consortium would be the storage of spent fuel, an activity of relatively low proliferation risk. Nevertheless, formulation of the control regime must take into account the possibility that the consortium may engage at a later date in operations of greater proliferation risk. The need to establish release criteria and mechanisms which are acceptable from the proliferation standpoint must also be considered from the outset.

In the following section, each of the principal specific elements of the control regime; i.e., verification, physical protection, acceptance and release and protection in transit are examined in terms of appropriate roles for each organizational tier, and preferred formulations are identified where possible.

4. Verification

The term "verification" is used to designate the activities undertaken by each tier to satisfy itself and others of the appropriate use of the facilities and materials in the hands of the consortium. The term "safeguards" is reserved for the verification system and activities of the IAEA alone. As in the case of the IAEA safeguards system, verification activities may include, to the extent appropriate, accounting, surveillance and containment measures.

It is clearly necessary and appropriate that plant management establish and maintain an effective materials accountability system, incorporating accounting, surveillance and containment measures.

Verification that diversion is not taking place is relatively straightforward in the case of spent fuel, especially at the local level. The unauthorized removal of spent fuel involves activities which could not escape the attention of plant operating forces and plant management. A significant feature of the control regime, which has implications for the responsibilities at each tier is that of multi-national staffing at the operating and management levels. While professional competence must be the controlling criterion in staffing the enterprise, this is not inconsistent with a reasonable requirement for multi-national staffing

A reasonable requirement to impose on the enterprise is that all personnel selected by it for employment receive a clearance from their respective national authorities. While the obvious implication of multi-national staffing is that any knowledge or suspicion of unauthorized activities will be communicated to management or higher authorities, it would appear to be neither necessary nor desirable to establish formal channels for communicating such knowledge, in view of the limited likelihood of irregularities or violations.

The verification roles of the enterprise itself and of the governmental-level General Council present more difficult issues from both the political and technical points of view. Consideration of these roles has been an

important factor in suggesting the organization structure presented in Section 3.3 (Part II). In this structure, a multi-nationally-staffed Audit and Control Bureau reports directly to the governmental-level General Council, but has a concurrent reporting responsibility to the enterprise as represented by the Board of Directors. While the Audit and Control Bureau would, for reasons of operational discipline and safety, have to comply with reasonable rules specified by plant management, it would be independent of management and neither the management nor the Board of Directors could limit the frequency and scope of access of the Control Bureau.

As explained in section 5, (Physical Protection) the activities of the Audit and Control Bureau are not limited to verification, but, perhaps more importantly, extend to physical protection as well. As national experience demonstrates, the effective application of physical protection measures, which the IAEA is not authorized to undertake, can make a direct, important and cost-effective contribution to verification, since they include measures which help ensure containment and surveillance of nuclear materials.

In light of the differences which have arisen in the relationship between the IAEA and EURATOM, it is reasonable to question the desirability or necessity of assigning a verification role to the consortium. In the view of the Study Group, this role is indispensable not only to the effective performance of the physical protection function (which the IAEA is not authorized to undertake), but to provide a portion of the data base for the effective application of IAEA safeguards. In effect, the intergovernmental tier of the multi-national consortium fulfills in this model the role of the "national system of accountability and control" called for by Paragraphs 7 and 31-32 of the IAEA safeguards system (INFCIRC 153).

There are two important corollaries of this conclusion. First, while the multi-national consortium has an important verification role within its overall control responsibility, this role should not diminish the rights and responsibility of the IAEA to verify the findings of the multi-national system. Second, an independent verification role by the host country seems superfluous. As a member of both the multi-national consortium and the IAEA, as the provider of at least a portion of the enterprise staff, and as the nation whose territory embraces the multinational facility, explicit measures of independent verification by the host country would seem to be not only redundant but in derogation of the status of the multi-national consortium.

It follows from the foregoing discussion that the final element of the verification function is the application of the IAEA safeguards system. While the Agency would be free, in deciding upon the details of application, to take into account the multi-national character of the institution as provided for in Paragraph 81(d) of the IAEA system, the Agency would be the final judge of the weight to be given this factor.

5.: Physical Protection

The allocation of responsibility for providing physical protection in a multi-national institutional setting presents inherently more difficult issues than does the question of verification. The provision of physical protection implies a degree of police power and operational control which, up until now, has been a national responsibility. At the same time, as observed in the preceding section, containment and surveillance which the IAEA is authorized to perform, had many elements in common with physical protection. The difference between an inspector engaged in

direct observation of a sensitive operation, and a guard performing the same surveillance role with the added authority to stop unauthorized actions is a small, although significant one.

several alternative models are potentially available. At one extreme, physical protection could continue to be the national responsibility of the host country, perhaps with responsibility to meet agreed upon standards, and to submit to periodic performance review by the consortium. While this system would, if effectively implemented, provide protection against subnational threats, it would involve no direct challenge or obstacle to threats by the host nation authorities themselves.

At the other extreme, physical protection could be the sole responsibility of the consortium, which would receive by treaty the necessary authority and force to deal with subnational threats and to interpose at least some obstacle to national takeovers. This alternative appears to place an unnecessary burden on the multi-national consortium in an area of extreme political sensitivity; i.e., the potential use of force against host country nationals.

An intermediate arrangement which appears preferable is to assign physical protection responsibility at and beyond the plant boundary to host country authorities, which would thereby become primarily responsible for protection against subnational threats. Responsibility for protection within the plant boundary under normal circumstances would be assigned to the Audit and Control Bureau of the consortium. The arrangements could also provide that national authorities would assist in control within the perimeter, should this be breached by subnational forces.

While it is manifestly impossible to endow the multi-national control staff with sufficient police power to

resist a forceful takeover by the host country, the Study Group attaches considerable importance to the principle that national violation of the basic undertakings should not be possible without the application of some force, however slight. The requirement that national authorities must resort to force to effect a takeover of the facility would change the basic character of the act, and create a situation where effective and international countermeasures might become both more acceptable and more likely. At a minimum, the political cost of violation would be elevated substantially.

A basically different alternative approach to problem of physical protection is to designate the storage site as an IAEA facility within the meaning of Article XII.A.5 of the Agency statute and assign responsibility for physical protection to the IAEA. This approach would not necessarily require major modification in the institutional model presented in this study. The interpretation of the statutory provision of "deposit with the Agency" is uncharted terrain, and there is no authoritative judgment as to whether the IAEA must be responsible for the physical protection of an Agency depository. Such an interpretation, however, cannot be ruled out a priori.

The designation of the facility as an Agency depository and the assignment of physical protection responsibility to the IAEA would, however, have important consequences for the decision-making process on acceptance and release of material, which is treated in the following section.

6. Acceptance and Release

The formulation of release criteria and mechanisms is among the most difficult and crucial of the many issues presented by multinational or international

concepts. Even in the case of spent fuel storage, which is not per se an activity of high proliferation risk, the condition under which stored material would be released constitutes a key aspect of the control regime.

Article XII.A.5 of the IAEA Statute prescribes, in general terms, a release mechanism which the Agency would presumably be required to comply with should the facility be regarded as an Agency depository within the meaning of this provision of the Statute. Under this criterion, the Agency appears obliged to release stored material upon request by the depositor, which, however, must be made on the basis of "need." While the practical application of this criterion calls for agreement on the concept of need, the discretion of the Agency under this formula to refuse delivery for broad nonproliferation reasons appears to be limited.

The assignment of responsibility to define and administer the release mechanism to the multinational consortium would have the virtue, at a minimum, of allowing the issue to be dealt with de novo, rather than on the basis of the Agency formulation.

Within the consortium, it seems clear that decisions relating to release are political ones which should be made by the intergovernmental General Council itself. One approach would be to adopt a requirement for unanimity on the release of material, in effect leaving for future determination the criteria that would guide release. Alternatively, a variety of voting formulations could be devised which would preclude release at sole discretion of the depositor, but which would also fall short of a veto power by each participant implicit in a requirement for unanimity. In any case, the absence of

some definition of the release criteria could adversely affect the willingness of countries to participate in the arrangement because of uncertainty as to whether and how the energy value of the deposited fuel might be recovered.

Another approach, therefore, is to seek to prescribe in the initial agreement the criteria which will govern release. For example, the criteria might include some evidence of international consensus on the back end of the fuel cycle, coupled with a need by the depositor for the material. Agreement on release criteria, however, would not overcome the need to agree upon the assignment of responsibility for administering these criteria. Approval by the General Council, even though bound to comply with the criteria, would necessarily involve some exercise of discretion and would create a need to prescribe from the outset the voting formula applicable to this exercise of authority.

The issue of the release mechanism also introduces important questions as to the role of the host country. Most, if not all, nations (including the U.S.) exercise control over the ingress and egress of nuclear materials. The substitution or imposition of this national control over material destined for or transferred from a multi-national facility, whether on U.S. territory or elsewhere, would, in some respects, seem to vitiate the multilateral concept itself. At the same time the fact that the U.S. already possesses a right of approval over reprocessing on much if not all of the spent fuel likely to be stored in a Pacific Basin depository raises the issue of the circumstances, if any, under which the U.S. might be willing to relinquish its right of approval to the multi-national consortium.

The release issue is closely related to the issue of expansion of the consortium's activities to other fuel cycle activities. Expansion to include some form of energy value recovery poses important technical, financial, and organizational issues. However, from a nonproliferation viewpoint, it is in effect a variant of the release issue, since the extension of the consortium's activities to include some form of reprocessing means that fuel would be released from storage to this reprocessing operation and thereafter to its original depositors or other parties. While the initial consortium agreement cannot realistically foresee the circumstances which will prevail if and when the scope of its activities are enlarged, it is important to agree at the outset on the principles - both substantive and procedural - to be applied to any proposed expansion. These agreed principles constitute an important part of the consortium's overall control regime.

7. Control of Material in Transit

Effective control over the facilities and materials within the consortium plant boundaries can be vitiated if appropriate arrangements are not made for control of material in transit to and from the storage site. While the need for this control is less in the case of spent fuel than recovered products, it is not entirely absent. The risk of sabotage may be as great or greater for spent fuel in transit than in the storage facility. Even the risk of seizure by either a consortium member or a third country cannot be said to be entirely absent, as the recently disclosed disappearance at sea of a substantial quantity of natural uranium illustrates.

Effective control during transit of the more sensitive number materials produced in future

reprocessing operations may be a crucial aspect of the future nonproliferation regime. The development of suitable measures applicable to transfer of material to and from the consortium's spent fuel storage facility may provide a valuable opportunity to deal with the complex issues involved in the security of material in transit.

The responsibility for protection of material in transit might logically be assigned to the same entity which discharges this responsibility at the plant site. In the proposed model, this is the Audit and Control Bureau of the consortium. This approach is facilitated by the fact that transportation would normally take place in dedicated vessels of the consortium. The international legal ramifications of assigning a security responsibility aboard ships in international waters to a multi-national entity are largely unexplored and require analysis. The nationality of the vessels in which material is transferred is a closely related issue.

Alternative approaches to allocating physical protection responsibility to the Control Bureau include placing this responsibility on the host country or on the IAEA. Such arrangements would seem to be logical only if responsibility for on-site physical protection were assigned to either of these organizations.

8. Previous Experience in Multinational Control Regimes

EURATOM

Because of the broad materials control and safeguard responsibilities assigned it under its founding Treaty, the Euratom case affords particularly important experience in any effort to formulate a control regime for a new multinational institution. At the same time, there are important limitations on the applicability of this experience to a multilateral institution of limited and special purpose such as one created to operate a spent fuel storage facility in the Pacific Basin. In contrast to this limited scope of activities, Euratom is a regional entity whose nuclear materials control responsibilities and authority extend to all nuclear materials and activities within the Territory of the Community, except those declared to be for defense purposes of a Member State. At the same time, despite this breadth of responsibilities, Euratom has not, except in the limited case of the Common Research facilities, been the proprietor of or directly responsible for the operation of nuclear fuel cycle facilities. as would be the case of a Pacific Basin spent fuel consortium.

In keeping with the supranational character of the European Communities, Euratom was endowed by its founding Treaty with important and exclusive responsibilities and authorities relating to the control of nuclear material. These include:

- (1) Exclusive legal ownership of all fissionable material in the Community, other than that withdrawn by a member for defense purposes.
- (2) Safeguards responsibility designated "Safety Control" in the Treaty); i.e., verifying that nuclear material in the Community is used for its intended purpose, undertaking accounting and inspection activities as necessary to accomplish the purpose.

(3) Responsibilities in the area of supply, including a right of option on all nuclear material produced within the Community, and the exclusive right to contract for supplies outside the Community, toward the end of ensuring equal access to resource.

Significant as these responsibilities are, they are subject to substantial limitations both in principle, and, perhaps more importantly, in the practices that have developed since the establishment of the Community in 1957. Among these are:

(1) While the Community continues to retain the legal title to fissionable material within its territory, beneficial rights to the material have in almost all circumstances, been exercised by the producer, or transferees of his choosing, and the practical effect of Community legal ownership has been minimal.

(2) The basic supply role of the Community - its responsibility to act, in effect, as an allocator of scarce resources, and supplier of last resort through the exercise of its option and foreign purchase responsibilities has been exercised only to a limited degree. Its principal application has come in the area of acquisition of enriched uranium or enrichment services from the U.S., but even in this circumstance, supply arrangements have in a substantive sense, become increasingly bilateral in character. The expected significance of the Euratom supply role has been limited, as it was in the case of the IAEA supply role at an earlier stage, by the fact that enrichment has not, in practice become a scarce resource. In the case of uranium, where the adequacy of supplies has become a source of concern, Member States and private enterprises have also largely sought their own sources of supply, rather than acting through the Supply Agency.

(3) While the Community was given the task of verification of use of nuclear materials and facilities within Community territory, it was not assigned responsibility either for physical security within the Community or for export control. These areas, which have emerged as major aspects of the overall proliferation issue, remain Member State responsibilities.

Given this background, it is in the area of safeguards that Euratom responsibilities and their relationship to U.S. policies and objectives have the most relevance to the question of how a new multilateral institution might be structured. In this regard:

(1) Euratom's safeguard responsibilities have been interpreted by both the Euratom Commission and the Member States as having a high degree of exclusivity. This has meant, in practice, a reluctance on the part of the Community to accept a major IAEA safeguards role, a circumstance which has led to difficulties in defining the respective safeguards roles of these two organizations.

(2) The U.S. delegated to Euratom, in the U.S.-Euratom Agreement of 1958, the responsibility for the application of safeguards which the U.S. had previously reserved to itself, pending establishment of an IAEA capability. While the U.S. did not question, in taking this step, the political objectivity of Euratom safeguards, the Agreement provided certain rights of mutual review to allow each party to satisfy itself of the technical adequacy of the other's system. The implementation of these rights and their adequacy to permit an effective mutual review of verification measures has proven to be difficult in practice.

It is difficult, of course, to judge the extent to which the considerations cited above are intrinsic to multilateral

organizations, and to what extent they represent consequences arising out of the particular circumstances of the Community's formation and evaluation. In any event, they reflect problem areas which must be carefully dealt with in the creation of any new organization.

Eurochemic and the ENEA

A specific case which has relatively close parallels to a potential Pacific Basin Consortium is that of the Eurochemic reprocessing project. As in the case of the PBC, Eurochemic was a multilateral consortium with responsibility for the construction and operation of a specific regional fuel cycle facility. Eurochemic was established by international convention under the aegis of the ENEA, and, as such, was subject to the security control (i.e., to the safeguards system of the ENEA's Security Convention) to be implemented by the "Security Bureau."

Given its Community location, however, Eurochemic was also subject to Euratom controls. Defining the relationship between these two systems, given the responsibilities of Euratom under its treaty, was a complex matter. This difficult was intensified by the fact that a major portion of the Eurochemic load was material of U.S. origin, and that the U.S. had an agreement only with Euratom for the application of safeguards.

Although a period of joint control existed for some time, the application of safeguards ultimately became an exclusively Euratom responsibility. The verification activities of the ENEA Security Bureau, largely as a consequence, did not evolve to any considerable degree.

Plant accountability control at Eurochemic, on the other hand, was effectively undertaken by the enterprise, itself a multinational entity, and an effective working relationship existed between the plant accountability organization and the Euratom safeguards authorities.