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INSTITUTIONAL ARRANGEMENTS FOR THE REDUCTION
OF PROLIFERATION RISKS

FORMULATION, EVALUATION, AND IMPLEMENTATION
OF INSTITUTIONAL CONCEPTS

EXECUTIVE SUMMARY

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ABSTRACT

The purpose of this study was to: 1) identify alternative institutional arrangements applicable to the sensitive steps in the back-end of the fuel cycle that might reduce their associated proliferation risks; and 2) assess their advantages and disadvantages from the standpoint of nonproliferation effectiveness and political, economic, and operational acceptability. The concept of international or multinational custody of sensitive materials and facilities was found to offer a high degree of proliferation resistance and to likely be more acceptable to prospective participants than other institutional arrangements that intrude upon proprietary areas, such as facility ownership and management.

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PREFACE

In furtherance of President Carter's Nuclear Nonproliferation Policy announced on April 7, 1977, the Department of Energy initiated the Nonproliferation Alternative Systems Assessment Program (NASAP) to evaluate the proliferation risks and economic and energy security characteristics of alternative nuclear fuel cycles. Later that year, in October 1977, the International Nuclear Fuel Cycle Evaluation (INFCE) was launched on United States initiative to conduct a similar study on an international basis. Although the primary orientation of both these undertakings was technical, it was widely recognized that institutional arrangements were directly relevant to the issues of nonproliferation and energy security. Accordingly, both NASAP and INFCE included consideration of institutional arrangements in their studies.

As part of a broader effort to develop information and concepts on institutional arrangements in furtherance of NASAP and the U.S. contribution to INFCE, International Energy Associates Ltd. was requested by the Departments of State and Energy to undertake a study of "Institutional Arrangements for the Reduction of Proliferation Risks." This work, initiated in June 1978, was performed under Subcontract No. 7605 with the Union Carbide Corporation - Nuclear Division, with financial support from the Departments of State and Energy. The purpose of the study was to: 1) identify alternative institutional arrangements applicable to the sensitive steps in the back-end of the fuel cycle that might reduce their associated proliferation risks; and 2) assess their advantages and disadvantages from the standpoint of nonproliferation effectiveness and political, economic, and operational acceptability.

This study was carried out in two distinct tracks. One track considered the applicability of detailed model institutions to existing facilities. The report of this track was submitted in draft form in January 1979, and was considered final by the sponsoring institutions. The other track systematically formulated and evaluated institutional concepts without constraint as to their applicability to existing facilities. This report is the culmination of that effort. Previous drafts of this report were provided to the sponsoring institutions in August 1978, February 1979, and July 1979. Frequent briefings regarding the progress of the work, as well as consulting services requested by the sponsoring institutions, also were provided.

The study was conducted by an IEAL project team which included Myron B. Kratzer, Project Manager, Edward F. Wonder, John E. Gray, Steven B. Shantzis, Nelson F. Sievering, Hilliard W. Paige, and Blythe M. Jones. The major research on the second track study, which is the subject of this report, was conducted by Messrs. Kratzer and Wonder, who are also the principal authors of this report. Principal researchers for the first track study were John E. Gray and Steven B. Shantzis, who were also the authors of the draft main report covering that study.

A number of other individuals contributed to the study in various capacities as consultants to IEAL, and the authors are pleased to take this opportunity to acknowledge their important contributions. In particular, Lincoln Gordon, of Resources for the Future, was the principal contributor to Appendix B, an analysis of the political implications of active use denial. Lawrence S. Scheinman, Cornell University, was an important contributor to the analysis of multinational ownership. Mr. Raymond Dickeman added his knowledge and expertise regarding industrial aspects of nuclear energy and contributed importantly to the economic and operational acceptability analysis of the model institutions.

A particularly important aspect of the study was the comprehensive review provided by a group of outside experts. In addition to the three individuals identified above, Phillip Farley, David Deese, and Mason Willrich participated in this review and offered valuable advice and comment.

Finally, IEAL wishes to acknowledge the invaluable assistance of individuals in the Department of State, the Department of Energy, and the Arms Control and Disarmament Agency, whose interest, critical review, and cooperation in providing guidance and background information were essential to the performance of this work. While many individuals played substantial parts in this way, we wish to mention with particular gratitude: Hugh Kendrick and Frederick McGoldrick of the Department of Energy; Frank Hodsoll and George Rathjens of the Department of State; and Charles Van Doren of the ACDA.

While recognizing the contributions and assistance of the individuals mentioned above, the authors accept full responsibility for the contents of the report and any errors of fact or omission.

M. B. Kratzer

E. F. Wonder

Washington, D.C.

December 1979

PRINCIPAL FINDINGS AND CONCLUSIONS

1. With the establishment by an increasing number of nations of sensitive fuel cycle facilities, the concern has grown that safeguards might not provide an adequate period of warning before the diverted material could be transformed into nuclear explosives. Improved proliferation resistance might be achieved in either of two general ways:

- avoiding sensitive facilities and materials by employing fuel cycles in which sensitive materials are not produced, or are rendered less sensitive or accessible by special treatment. This is the technical approach; or
- eliminating or restricting national access to sensitive facilities and materials by placing these in international or multinational hands. This is the institutional approach.

The importance of this institutional approach is given explicit recognition in the Nuclear Non-Proliferation Act of 1978 which calls for a "prohibition against reprocessing" except "in a facility under effective international auspices and inspection."

2. Despite considerable attention in recent years to possible institutional arrangements for the conduct of sensitive fuel cycle activities, there has been little or no systematic analysis of:

- the precise nature of the nonproliferation benefits which can be derived from international or multinational institutional arrangements;

- the characteristics required of such institutions in order to yield these benefits; and
- the political, economic, and operational impacts of such institutions and their implications for acceptability of the institutions.

3. An important objective of the study has been the development of a systematic methodology for formulating institutions and evaluating them from the dual perspective of nonproliferation effectiveness and acceptability. The heart of the methodology, and that which leads to the most important results of the study, is the separate identification and assessment of the various features of an institution. By examining each institutional feature separately from the standpoint of both its proliferation resistance in relation to each proliferation threat and its effect on the acceptability of the institution, it has proven possible to formulate an institutional arrangement which provides important nonproliferation benefits while avoiding those features which are most likely to be unacceptable to potential members.

4. The use of the methodology described above has led to the conclusion that the principal source of improved proliferation resistance offered by institutional arrangements is the assignment of responsibility for materials control to a suitably constituted international or multinational institution. The internationalization or multinationalization of such institutional features as ownership, management, and operation yield relatively less important nonproliferation benefits, while significantly lessening the acceptability of the arrangements to potential members.

As a result, the optimal institutional arrangements from the standpoint of both nonproliferation benefits and acceptability may be those in which sensitive facilities remain under national

ownership, management, and operation but function under a regime of control over ingress and egress and inventories of sensitive material, which has been designated "custody".

The custodial arrangement postulated in this study goes well beyond international safeguards designed only to verify compliance with nonproliferation undertakings, and would appear to fall within the scope of the statutory term "effective international auspices", which is given prominence in the Nuclear Non-Proliferation Act of 1978.

5. The custody concept is applicable to institutions of either international or multinational membership. However, there appear to be significant advantages in multinational custodial institutions from the viewpoint of both their nonproliferation effectiveness and their probable acceptability.

6. The custody concept appears to offer good prospects for early implementation, thus taking advantage of the current receptivity toward improvements in the nonproliferation regime. An attractive near term possibility for the application of the concept are the pilot scale reprocessing facilities in operation in several countries. Inclusion of these facilities in a custody-type institution could provide an early demonstration of the concept, as well as a nucleus which could grow through the addition of larger facilities and more members.

7. The relationship of multinational custody institutions to the IAEA requires careful consideration. In addition to its indispensable role of applying safeguards, the IAEA can play an important role in ensuring the nonproliferation bona fides and the observance of minimum standards by each custody group through appropriate relationship with the agency. If the IAEA is successful in establishing an international plutonium storage arrange-

ment, this arrangement should displace the custody regimes insofar as central plutonium stores are concerned. Finally, if a single custody organization evolves, it could become a specialized arm of the IAEA itself.

8. An association of national facilities represents the least intensive form of institution. It would leave ownership, management, and operation of sensitive facilities in national hands (although not precluding voluntary formulation of multinational enterprises), but would associate these national activities in an organization whose principal purpose is to adopt a code of non-proliferation conduct to be followed by participants.

A basic thrust of the concept is to seek to limit the number and geographic spread of reprocessing facilities beyond those included in the association as originally constituted. In the view of the limited nonproliferation effectiveness of the association, other institutional arrangements, involving active control of sensitive material, appear necessary.

9. Despite the key role of safeguards in nonproliferation policy, much of the present concern over proliferation risks stems from doubts as to the adequacy of safeguards. These reservations center on:

- technical effectiveness
- scope
- continuity
- limited purpose

The most important issue is the limited purpose of safeguards for the detection rather than the prevention of diversion or seizure. Even technically infallible safeguards capable of giving immediate warning of the diversion or seizure of sensitive material will not prevent this action. Despite this limitation, there is good

reason to make safeguards as technically effective as they can be within reasonable resource levels.

10. Safeguards effectiveness can be improved by:

- relaxation or elimination of current restrictions on the frequency and intensity of IAEA inspection at the most sensitive facilities;
- lifting of restrictions for ad hoc and special inspections;
- improved funding of safeguards, including, if necessary, direct assessment of nuclear power generating countries; and
- clear establishment that safeguards are irrevocable for both NPT and non-NPT countries, at least with respect to equipment, materials, and technology supplied in reliance on safeguards.

11. This concept would entail increased costs for both the inspectorate and the inspected facility or state, but there is convincing evidence that technically effective safeguards will not impose costs which significantly affect nuclear power economics. If improved safeguards were the only or the principal measure called for to alleviate current proliferation concerns, it is likely that a number of countries would be prepared to accept the financial implications. A similar conclusion can be reached with regard to political acceptability.

12. As in the case of nationally owned facilities under international or multinational custody, multinational ownership does not

provide infallible protection against the proliferation risks of diversion, host-country seizure, or abrogation. Moreover, it presents greater risks of technology transfer, although these risks will depend on the exact nature and degree of multinational participation in management and operation. Multinational ownership arrangements can, however, offer greater benefits than custody alone in limiting the number and location of sensitive plants.

To be effective, multinational ownership of reprocessing, like custody, would have to be coupled with an international plutonium management regime to reduce proliferation risks connected with the storage, release, shipment and use of plutonium produced in the multinational plants.

13. In terms of acceptability, multinational ownership and management involve complex considerations which work both for and against acceptability. In general, such arrangements tend to be viewed as encroaching on national fuel cycle decisional authority and entailing increased management complexity. However, for countries with limited markets, and limited technological and financial resources, participation in a jointly-owned fuel cycle facility may be the only realistic means of engaging in the activity in question. Thus, ownership arrangements would probably be favored over custody arrangements by countries which are not likely to be host nations in the foreseeable future. Custody institutions would almost certainly be preferred by large industrialized countries able to build and operate facilities on a national basis.

14. A global fuel cycle authority might be able to provide proliferation resistance beyond that offered by multinational ownership institutions in three respects:

- the universality of the approach might increase pressures on reluctant nations to participate;
- the supply assurances of the global authority may inspire greater confidence and thus more effectively discourage independent national programs; and
- the risks of a segmented market, in which some suppliers offer services with less stringent nonproliferation conditions, would be reduced to the extent that the institution is successful in achieving universality.

15. In contrast to these advantages, a global authority would be far more difficult to construct than a set of multinational institutions. Moreover, its broad membership could dilute the assurance and effectiveness of its response to violations, and thus its deterrent capability. Response could well be dependent on the identity of the violator and the current international political standing of the country.

16. In addition to nonproliferation effectiveness and acceptability, the criteria which govern when and how implementation of institutional concepts should be attempted are:

- applicability to existing facilities;
- maximum involvement of sensitive countries;

- suitability for expansion of membership, without stimulation of undesirable sensitive facilities; and
- appropriate composition.

While an evolutionary approach is appealing and reasonable, specific institutions, once created, cannot be readily upgraded in their authority to apply nonproliferation measures.

Thus, it is preferable to create institutions capable of doing what is needed, and seeking additional membership as time goes on, rather than water down institutional capabilities to attract a maximum initial membership. This is the approach successfully followed in the case of the NPT.

17. The basic alternatives available in terms of grouping countries in a custody institution are:

- a single institution in which all concerned countries would participate, although not necessarily from the outset; or
- a set of multinational groupings.

The second alternative may be preferable to a single institution from the standpoint of both nonproliferation effectiveness and acceptability. This approach also has advantages in terms of the implementation criteria outlined above, and, in particular, the desirability of an early start.

If a multinational custody institution is successfully established, however, a possible outcome is that most countries of interest would seek to join this group in preference to establishment of a separate one. If events follow this course, there is no compelling reason to foreclose this outcome, despite the advantages seen for separate institutions.

18. Participation in custody institutions by customers as well as suppliers of reprocessing services is clearly preferable to institutions in which only suppliers participate. The expansion of institutions by the addition of new members should take place in accordance with clear criteria limiting additional host-countries to locations where there is an economic rationale for such facilities.

INSTITUTIONAL ARRANGEMENTS FOR THE
REDUCTION OF PROLIFERATION RISKS

EXECUTIVE SUMMARY

I. Introduction

The Role of Institutional Arrangements in Nonproliferation Policy

1. Nuclear power activities are a potential source of the nuclear material and technology essential to the development of nuclear explosives, and nations which decide to seek nuclear weapons may take advantage of the nuclear fuel cycle to help reach this goal, or may even be influenced in their decision by their access to the nuclear fuel cycle. This risk, although recognized since the outset of cooperation in the peaceful uses of nuclear energy, is greater now than at any time in the past both because of the growing number of countries engaged in nuclear power activities, and the increased sensitivity of the fuel cycle operations now being undertaken or planned.

2. To allow nuclear power activities, and especially international cooperation, to go forward without unacceptable risk of proliferation, a regime has come into being to provide assurance that peaceful nuclear activities will not be directed toward the development of nuclear weapons. Central to this regime are national undertakings, whether given bilaterally or multilaterally, that peaceful nuclear activities will not be used for nuclear explosive purposes. These undertakings are subject to verification through on-site inspection by international civil servants. In this, and other ways, international institutions are already playing an important role in providing assurance that peaceful nuclear activities will not be

applied to the development of weapons. With a few important exceptions, however, nuclear power activities are taking place under national auspices, subject only to international verification of peaceful uses.

3. With the establishment by an increasing number of nations of sensitive fuel cycle facilities the concern has grown that safeguards might not provide an adequate period of warning before the diverted material could be transformed into nuclear explosives. In response to this concern, the United States has sought a deferral of the commercialization of reprocessing and the use of plutonium until means of satisfactorily limiting the proliferation risks of plutonium could be developed. Examination of this objective indicates that improved proliferation resistance might be achieved in either of two general ways:

- avoiding sensitive facilities and materials by employing fuel cycles in which sensitive materials are not produced, or are rendered less sensitive or accessible by special treatment. This is the technical approach; or
- eliminating or restricting national access to sensitive facilities and materials by placing these in international or multinational hands. This is the institutional approach.

The importance of the institutional approach is given explicit recognition in the Nuclear Non-Proliferation Act of 1978, which calls for a "prohibition against reprocessing" except "in a facility under effective international auspices and inspection."

4. Institutional and technical measures for the reduction of proliferation risks are not mutually exclusive, and may well

be complementary. At the same time, there are likely to be trade-offs between technical and institutional measures. The adoption of effective technical measures may reduce both the need for and the political acceptability of institutional means of avoiding national access, and vice versa.

The Purpose and Scope of the Study

5. Despite considerable attention in recent years to possible institutional arrangements for the conduct of sensitive fuel cycle activities, there has been little or no systematic analysis of:

- the precise nature of the nonproliferation benefits which can be derived from international or multinational institutional arrangements;
- the characteristics required of such institutions in order to yield these benefits; and
- the political, economic, and operational impacts of such institutions and their implications for the acceptability of the institutions.

6. Given the recognized potential of institutional arrangements for the reduction of proliferation risks and the limited amount of information on their characteristics in this regard, it is the purpose of this study to identify and assess possible institutional arrangements which might reduce the proliferation risks otherwise attendant on the performance of sensitive fuel cycle operations. While sensitive operations occur in both the front-end of the nuclear power fuel cycle (i.e., enrichment) and the back-end (e.g. reprocessing, plutonium transfer and storage, plutonium fuel fabrication), this study is explicitly directed only toward the back-end

of the fuel cycle. It is believed, however, that many of the results of the study and, in particular, its methodology are applicable to the front-end as well.

7. As originally conceived, the study proceeded on two independent tracks:

- An examination of institutional arrangements which might be applicable at an early date to existing back-end fuel cycle enterprises; and
- The more unconstrained and systematic study described above.

Following review of the preliminary results from both tracks, it was decided in consultation with the sponsoring Agencies that only the second study should be carried to the stage of a final report. The results of the first study, however, are summarized in this Executive Summary (See Section VI).

8. The performance of this study implies no value judgment on the part of either the sponsoring Agencies or IEAL on whether reprocessing should or should not be favored. Rather, the study is intended only as one part of an overall examination conducted under the auspices of NASAP of a variety of technical and institutional alternatives in support of U.S. participation in INFCE and other policy-oriented activities.

Methodology of the Study

9. An important objective of the study, which has been given considerable emphasis, has been the development of a systematic methodology for formulating institutions and evaluating them from the dual perspective of nonproliferation effectiveness and acceptability. This methodology consists of the following steps:

- Identification of the various types of proliferation threats to which sensitive fuel-cycle facilities and materials are subject. These include diversion, seizure, abrogation, and undesirable technology transfer.
- Identification of various features of institutional arrangements; for example, ownership, management, staffing, siting, and function; and the separate assessment of how each of these affects resistance to each of the proliferation threats.
- A similar evaluation of how each institutional feature affects the political, economic, and operational acceptability of the institution.
- The application of these separate assessments to a spectrum of model institutional arrangements, ranging from arrangements which involve only the adoption of a common code of nonproliferation conduct by an association of national fuel cycle enterprises to a global fuel cycle authority.

10. The heart of the methodology developed, and that which leads to the most important results of the study, is the separate identification and assessment of the various features of an institution. By way of illustration, an institution can be internationally or multinationally owned, but nationally managed and staffed; it may be nationally owned and managed, but internationally staffed; or it may be nationally-owned, managed, and staffed, but subject to international control and custody of sensitive materials. By examining each institutional feature separately from the standpoint of both its resistance in relation to each proliferation threat and its effect on the acceptability of the institution, it has proven possible to formulate an institutional arrangement

which provides important nonproliferation benefits while avoiding those features which are most likely to be unacceptable to potential members.

Results

11. The use of the methodology described above has led to conclusions which are felt to be of significant value in the further consideration of institutional arrangements for the reduction of proliferation risks. In brief, it is a conclusion of this study that the principal source of improved proliferation resistance offered by institutional arrangements is the assignment of responsibility for materials control to a suitably constituted international or multinational institution. The internationalization or multinationalization of such institutional features as ownership, management, and operation yield relatively less important nonproliferation benefits, while significantly lessening the acceptability of the arrangements to potential members.

12. As a result, the optimal institutional arrangements from the standpoint of both nonproliferation benefits and acceptability may be those in which sensitive facilities remain under national ownership, management, and operation but function under a regime of control over the ingress and egress of personnel and material and overall inventories of sensitive material. This institution has been designated "custody."

13. While this concept is applicable to institutions with either international or multinational membership, there appear to be significant advantages in multinational custodial institutions from the viewpoint of both their nonproliferation effectiveness and their probable acceptability. The custodial arrangement postulated in this study goes well beyond international safeguards designed only to verify compliance

with nonproliferation undertakings, and would appear to fall within the scope of the statutory term "effective international auspices," which is given prominence in the Nuclear Non-Proliferation Act of 1978.

Implementation

14. As a final task, consideration has been given to how selected concepts, in particular that of custody, might be implemented. Since participation in institutional arrangements involves restraints, participation will normally require incentives or inducements in some form. These incentives or inducements may be either intrinsic to the institution, or extrinsic. An important conclusion of the study is that creation of an institution and continued participation in it should be based, in so far as possible, on the intrinsic benefits of membership, including the reduction of proliferation risks. Extrinsic benefits or inducements, no matter how persuasive when first employed, can change or erode with time, thus jeopardizing the continued viability of the institution.

15. The custody concept appears to offer good prospects for early implementation, thus taking advantage of the current receptivity toward improvements in the nonproliferation regime. An attractive near-term possibility for the application of the concept are the pilot scale reprocessing facilities in operation in several countries. Inclusion of these facilities in a custody-type institution could provide an early demonstration of the concept, as well as a nucleus which could grow through the addition of larger facilities and more members.

II. Institutional Analysis

1. Institutions must be evaluated from the standpoint of both their nonproliferation effectiveness and their political, economic, and operational acceptability. Ideally, institutional arrangements should be sought in which acceptability is achieved with little or no sacrifice of nonproliferation effectiveness.

2. The central feature of the analytical approach developed and employed in this study is the separate identification and assessment of each major institutional feature both in terms of how it affects proliferation resistance and how it affects the acceptability of the institution. Moreover, both proliferation resistance and acceptability are examined in terms of their component parts. The demonstration that the various features of international or multinational institutions -- such features as institutional membership, ownership, management, staffing and the like -- need not all be internationalized in the same degree, or indeed, not at all, and that each has its separate effect on proliferation resistance and acceptability, is one of the most important results of the study. The approach enables the various features of institutions to be put together so as to optimize proliferation resistance and acceptability. It also provides a tool for assessment of institutional proposals that may be put forward.

Nonproliferation Effectiveness

3. Institutions may provide nonproliferation benefits of two kinds:

- intrinsic benefits; that is, those which reduce the likelihood that proliferation will result from a given activity conducted under the institution's

auspices, as compared with the same activity taking place nationally;

- extrinsic benefits; that is, the reduction in proliferation risks resulting from a reduction in the number and geographic spread of the sensitive activities in question, involving both members and non-members of the institution.

This distinction illustrates the importance of designing institutions which not only increase the proliferation resistance of the institutions and activities to which they apply, but also help limit the spread of these activities.

4. The intrinsic proliferation benefits must also be considered in terms of each of several possible proliferation pathways. These are:

- Diversion; the attempted clandestine removal of sensitive materials.
- Seizure; the overt and large-scale takeover of a sensitive facility or stocks of material for unauthorized use.
- Abrogation or withdrawal; steps taken by a national authority to free itself of nonproliferation undertakings, either by exercise of withdrawal rights or otherwise.
- Technology transfer -- the unwanted diffusion of sensitive technology resulting from multinational participation in the ownership, management, staffing, operation, or safeguards-related surveillance of the sensitive activities conducted by the institution.

5. Proliferation resistance to each of these threats must be considered in terms of each of three major considerations. These are comparable to those applied in much of INFCE's consideration of proliferation resistance:

- Difficulty -- How does each institutional feature affect the economic, technological, or political difficulty of misuse of sensitive activities?
- Detectability -- How does the feature affect the likelihood and timeliness of detecting any misuse?
- Consequences -- How does the feature affect the likelihood of an effective response to actual or threatened misuse?

Institutional Features

6. The major features which characterize an international or multinational institution are the following:

- Composition -- Whether the institution is international (i.e., essentially global in membership, or membership eligibility) or multinational (i.e., open only to membership by a relatively limited number of countries), and the actual identity and characteristics of the members.
- Ownership -- Whether ownership is national, or is shared by some or all members of the institutions, and the details of any joint ownership.
- Management -- Whether national or multinational.
- Staffing -- Whether national or multinational.

- Siting -- Where and how many sensitive facilities are operated under the institution's auspices.
- Function -- Whether the function of the institution is to develop and apply a code of conduct, to apply safeguards, to control and have custody of sensitive facilities and material, or to operate facilities.

7. The composition of an institution is of major importance in determining resistance to all proliferation threats. To provide proliferation resistance, a multinational institution must include countries which have:

- genuine adverse interest against proliferation by any non-nuclear weapons member state.
- adequate managerial and technical competence to discharge the nonproliferation-related responsibilities assigned to the institution.

Proliferation resistance, moreover, can be greatly enhanced by a composition which includes countries which are strongly interdependent politically, economically, and perhaps even in mutual defense. Such interdependence will deter any violation of nonproliferation undertakings and increase the likelihood and effectiveness of the response if violation should occur. For this reason, properly constituted multinational institutions may possess greater proliferation resistance than broadly based international ones, where the response may be more diffuse.

8. Despite a common presumption that international or multinational ownership is a necessary feature of an international or multinational institution, such ownership plays only a limited role in providing intrinsic proliferation resistance. The role of ownership in extrinsic proliferation resistance

may be important, if participation in the ownership of a multinational facility contributes to limiting the number or geographic spread of sensitive facilities.

9. As in the case of ownership, management has only a limited role in providing proliferation resistance, although multinational management could make the planning and execution of diversion or seizure somewhat more difficult. Multinational management, if intensive, could increase the risk of unwanted technology transfer.

10. International or multinational staffing can make a significant contribution to resistance against diversion by providing a "built-in" inspection capability. Multinational staffing would increase risks of unwanted technology transfer, although this concern could be mitigated if the multinational presence were confined to areas of particular sensitivity from the standpoint of diversion potential.

11. Siting is of importance from the standpoint both of where plants are built and how many are built. While the ideal arrangement would be to confine sensitive facilities to existing nuclear weapons states, this will be politically impractical. Alternatives which should be considered include siting in stable neutral countries without interest or incentive to acquire nuclear weapons. Important as siting is, however, institutions should be designed to provide effective proliferation resistance regardless of facility location, since, in the long run, strict siting restrictions may not be sustainable.

12. Institutional functions cover a range from the adoption of a common code of nonproliferation conduct by countries with facilities which otherwise remain fully under national auspices, to full-fledged operation of sensitive facilities by the

institution. In the latter case, staffing and management and, in all probability, ownership as well would be international or multinational responsibilities. The important intermediate cases considered in this study are the application of improved safeguards, and an intensified regime of materials control, designated "custody." While the nonproliferation effectiveness of the institution improves from the least intensive to the most intensive end of this spectrum, a key conclusion of the study is that the most important nonproliferation benefits, together with greater prospects for acceptability, accompany the function of "custody."

13. Custody has been chosen to designate a set of legal rights and actual physical control over sensitive facilities and materials for the sole purpose of guarding against their use for unauthorized purposes. These controls would be exercised by personnel of the institution with authority vis-a-vis the host country itself. A central feature of the arrangement is control over the ingress and egress of sensitive materials to assure their use only for authorized purposes. While the focus of custody would be on materials, it would extend to the use of sensitive facilities, since such facilities could, in some circumstances, quickly produce strategic amounts of sensitive materials. The analysis reaches the conclusion that custody is the key institutional feature for providing improved proliferation resistance against national seizure or abrogation.

Political, Economic, and Operational Assessment

14. The same institutional features which influence proliferation resistance also have political, economic, and operational implications which affect the acceptability of the institution. One additional feature of particular importance to acceptability has been identified in addition to those dealt with in the assessment of proliferation resistance.

This is the market for the services supplied by the institution or the facilities which operate under its auspices -- that is, whether the market is national, coincident with the membership of the institution, or even broader.

15. Despite contrary impressions, the implications of these features for institutional accessibility are not necessarily unfavorable. International or multinational institutions may offer significant economic and political benefits to some countries, and several successful multinational fuel cycle institutions have been created for these reasons.

16. Economic criteria include domestic economic impacts, economies of scale, and financing. Among the principal economic impacts for many countries is the foreign exchange cost of relying upon a fuel cycle facility located in another country. This disadvantage, however, may be offset in whole or in part by economies of scale which accompany a centralized facility serving a multinational market.

17. Multinational ownership may yield advantages in terms of financing costly fuel cycle facilities by allowing pooling of financial resources of several countries. This is one example of a fairly general principle: that the benefits of multinational institutions are of greatest significance to countries of limited size and industrial development which would find it difficult or impossible to proceed with costly and sophisticated fuel cycle facilities entirely on their own resources. For larger countries with large internal markets and adequate financing and technological capacity on a national basis, the internationalization or multinationalization of ownership, management, and staffing may be of little importance, or may even be viewed as an undesirable added complication. For these countries, the justification for engaging in international or multinational institutions may have to be found in the nonproliferation and other political benefits which the institution provides.

18. A key issue in assessing the political acceptability of an institutional arrangement is its impact on energy security and the self-determination of energy policies. When responsibility for undertaking a particular step or steps of the nuclear fuel cycle is delegated to an international or multinational institution, the national ability to unilaterally determine the size, scope, and structure of the national fuel cycle will be circumscribed. Few countries would fail to regard this as a disadvantage, but the seriousness with which it is viewed would vary considerably, and would depend heavily on the extent to which the institution was perceived as a stable, reliable, and efficient supplier of the services in question. To the extent that the institution supplants national supply, it must offer reliable fuel assurances.

19. Where multinational or international institutions are relied upon, interdependence may supplant self-sufficiency as the means by which energy security is achieved. This suggests that institutions of relatively limited membership whose members have many areas of interdependence and common interests may be more acceptable than broadly-based institutions from the standpoint of energy security.

20. The acceptability of institutional arrangements can also be affected by domestic political considerations other than energy security. The desire to participate in sophisticated fuel cycle technology activities for reasons of prestige or a belief that this will contribute to industrial development could work against participation in an institution which required avoidance or deferral of undertaking these activities domestically.

21. Foreign policy consideration can also be expected to have an important influence on institutional acceptability.

Participation in fuel cycle institutions would generally be favored by the desire to demonstrate the peaceful nature and objectives of a country's nuclear power program. A country's desire to place potential rival's or adversary's programs under the same restraints provides an incentive for it to promote the institutional concept. On the other hand, a nation's desire to demonstrate political and economic leadership could work against its willingness to subordinate its fuel cycle interests to an international or multinational institution. In the worst case, a country's desire to preserve fuel cycle independence either to retain the option or actively prepare for nuclear weapons development could constitute the strongest and most unfortunate basis for opposition to participation.

22. As in the case of proliferation resistance, the acceptability of an institution is affected in differing ways and degrees by each separate institutional feature. Composition affects political, economic, and operational acceptability by determining both the quality and the scale of the financial and technological resources available to the institution and its potential market. For institutions which have custody as their major responsibility, the political rather than the financial and technological characteristics of the potential participants will be of greatest importance. Unless participants share a firm commitment to proliferation, the effectiveness of the institution can be seriously jeopardized. Nevertheless, the inclusion of countries with doubtful nonproliferation credentials should not be arbitrarily rejected, since it is precisely to the proliferation potential posed by such countries that custody is directed.

23. Joint ownership of sensitive fuel cycle facilities gives nations which do not have an economic need or capacity for their own facilities an opportunity to participate in

activities which they may regard as important. Participation in ownership may also improve the perceptions of reliability of supply. Countries will not be prepared to make the investments implied by ownership without the strongest possible assurances that their supply commitments to them will be met. Ownership can provide smaller countries a voice in fuel cycle decisions that they might otherwise lack. For large countries that could proceed on their own resources, however, joint ownership dilutes the national control they might otherwise have.

24. The market of a fuel cycle institution has particular implications for its acceptability. In principle, a facility could participate in an international or multinational institution while still serving a wholly or predominantly national market. For institutions whose principal function is the adoption of a code of conduct, there need be no particular implication that each participant's services will be offered to other members. However, the extension of services performed by participating institutions to at least all members would be a normal and expected feature, particularly if the institution had responsibility for custody. A multinational market would also open opportunities for economies of scale which could benefit all participants. Most importantly, if the institution imposes restrictions on some or all of its members' right to engage in particular fuel cycle activities, it must make the services in question available to these restricted members on a reliable and stable basis.

25. Management constitutes the institutional feature which has probably played the greatest role in discouraging interest in international or multinational fuel cycle facilities. If management is to be international, efforts are usually made to insulate the management in some degree from the direct political influence or interference of member states. Multi-

tiered arrangements, in which political decisions are made by a senior political body while management is exercised by a professional staff hopefully chosen on merit, are a customary approach. The lead-country concept, in which management responsibility is predominantly exercised by a single country, usually the host national, is another approach. Experience has been mixed and there are examples of efficiently managed international or multinational institutions, but there is ample evidence that the common concerns as to the effectiveness of institutional management are well-justified.

26. Institutions where ownership and even management are multinational could, nevertheless, avoid or severely limit multinational staffing. This would most likely arise from a desire to avoid unwanted technology transfer. In addition to its benefits in improved capability for detection of diversion, multinational staffing could significantly promote political acceptability by providing training and hands-on experience to personnel of non-host nations. The importance of this would depend heavily on the ground-rules of the organization with regard to allowing additional member countries to acquire their own facilities at some stage.

27. Siting has an important impact on all elements of acceptability -- political, economic, and operational. Economically, siting policy will determine whether a given fuel cycle activity will represent a foreign exchange or a domestic cost for any given participant, and whether there is a potential for change in the status of a participant as his economic needs and technological capability grows. It is in the political area, however, where siting takes on greatest importance. Particularly where regional rivalries are involved, disagreement over siting may be an intractable problem, unless all of the rivals are selected as host nations. As suggested earlier, the existence of strong ties of interdependence among prospective members can help overcome

concerns over the reliability of the host country.

28. Siting which is confined to nuclear weapons countries or to advanced industrialized countries would raise the issue of discrimination against the members outside these categories. While the status of host nation would normally be expected to be sought after, it could become a serious obstacle to acceptability if the public of the proposed host country saw little domestic benefit and significant disadvantages such as the obligation to dispose of radioactive wastes. In general, countries which can mount their own national effort are unlikely to want to become the host for a multinational institution when difficulties such as waste disposal are present. Even if this difficulty is avoided by returning waste to the customer, the desire of advanced countries to internationalize or multinationalize their sensitive fuel facilities is likely to be limited.

29. The functions performed by the institution also affect acceptability. Safeguards are largely neutral in terms of economic and operational impact, and should have far less political impact than measures which impose multinational custodial control or operation on a given facility, or measures which restrict siting. A code of conduct would ordinarily not have an economic or operational impact on facilities themselves, but could have significant impact on overall economic considerations for participants, for example, by limiting export opportunities for technology or services. Such a code of conduct could also present major political difficulties even for suppliers if it were regarded as discriminatory by consumers.

30. Since an institution with custody as its function would not necessarily require international or multinational ownership, management, and staffing, many of the political, economic and operational disadvantages associated with the

internationalization or multinationalization of these features would be avoided. Since these disadvantages most strongly affect countries which are capable of undertaking the fuel cycle activities in question on their own, custody appears to be a particularly appropriate approach for activities conducted by industrial countries.

31. Custody would, however, not confer the economic advantages of multinationalization where these exist. This suggests that a desirable approach would be to make multinational ownership, management, and the like permissive but not compulsory features in arrangements which are based primarily on custody.

32. Custody has a particular political characteristic not shared by any other institutional feature, in that it would operate with respect to even the host country itself; that is, the host country will have no greater unilateral right of access to the material than any other member. This non-discriminatory characteristic would clearly be a political advantage in the eyes of all but the host country. For the host, it could well represent the critical political issue in terms of domestic acceptability.

33. Although institutions with direct responsibility for operation of a fuel cycle facility represent the most intensive form of international or multinational arrangement, it is not a foregone conclusion that such an institution would be unacceptably inefficient or politically unacceptable. The fact that successful examples exist suggests that the arrangement can be viable where the parties are industrialized countries which cooperate closely in many undertakings. Nevertheless, a key conclusion of this study is that the nonproliferation benefits of this form of institutional arrangement are not so great as to warrant its being a compulsory feature of an institution designed for the reduction of proliferation risks.

III. Fuel Cycles and International Institutions

1. Of direct importance to the assessment of the institutional approach to reduction of proliferation risks is their relationship to technical measures to accomplish the same objective. If effective technical measures become available, they may eliminate the need, or at least significantly change the nature of the required institutional measures. They may also make institutional arrangements more difficult to achieve, since countries which have been persuaded to accept technical proliferation resistance measures may be reluctant to accept institutional restraints as well, particularly if the technical measures involve significant costs.

2. Despite the large number of technical approaches to improved proliferation resistance which have been or are being considered, it is possible to group these measures in three classes from the standpoint of their probable effect on and relationship with institutional arrangements. These classes are:

- Modifications to sensitive nuclear material which make them more proliferation resistant.
- Modifications to sensitive processes or facilities to make them more proliferation resistant, in combination with the production only of proliferation resistant materials.
- Measures referred to as active use denial, by which allow sensitive plants can be rendered inaccessible or unusable in the event of attempted misuse.

3. Measures to make sensitive materials more proliferation resistant, in general, involve the introduction of either a radiation barrier to hamper unauthorized use, or isotopic dilution to render the material unsuitable for nuclear explosives. Each of these approaches has advantages and disadvantages from the standpoint of both proliferation resistance and acceptability, which are not examined in detail in this study. Steps such as colocation of reprocessing and version fabrication facilities, and coprocessing to yield a mixed oxide product rather than pure plutonium compounds are not regarded as significant nonproliferation measures in this study, although they may be useful and justified to improve protection against subnational threats.

4. From the institutional point of view, even if measures to render fresh fuel more proliferation resistant are highly effective, they would not alleviate the need for progress in institutional arrangements to assure adequate proliferation resistance at reprocessing facilities themselves. Of equal importance, the current evidence is that there are no practical means by which fresh MOX fuel can be made as proliferation resistant as spent fuel. All measures examined fall well short of this, both in terms of intensity of the radiation barrier and its longevity. Moreover, all of those measures would significantly complicate fuel cycle operations, and may therefore be unacceptable.

5. Isotopic dilution (i.e. the dilution of U-233 with U-238 to levels below that required for nuclear explosives) may be a more effective nonproliferation measure, in light of currently limited capabilities for isotope separation. However, this approach implies major changes in the nuclear fuel cycle, and probably in reactors as well, involving long and costly development effort. It also requires reprocessing, in which plutonium would still be separated, thus calling for institutional protection over reprocessing and any use

of plutonium. Given this requirement, the concept shows little or no nonproliferation advantage over a regime in which reprocessing for current generation reactors is performed under institutionally secure arrangements, plutonium use is limited to secure locations, and LEU fuel is delivered to all other locations.

6. Measures which would make both sensitive facilities and their products more proliferation resistant would, in principle, reduce the need for institutional arrangements. In practice, however, the benefits which can be achieved from this approach appear limited and unavailable for some years to come. Concepts such as Civex do not lead to the production of fresh fuel with proliferation resistance equivalent to that of spent fuel, and access to the reprocessing facilities involved would provide extensive knowledge on the design and operation of reprocessing plants capable of producing completely decontaminated plutonium. Thus, this and similar concepts do not allow unrestricted siting of reprocessing plants or unrestricted distribution of their products. While the concept of proliferation resistant reprocessing facilities merits detailed examination, it does not allow any relaxation in effort on institutional approaches.

7. Active use denial is a relatively new concept for imparting proliferation resistance to reprocessing and other sensitive facilities which poses novel problems of both a technical and political nature. The political acceptability of any system which renders costly fuel cycle facilities temporarily or permanently inaccessible or unusable is dependent, at a minimum, on a virtually infallible warning and command and control system. Such a system is unavailable at present and may not be achievable.

8. Another important limitation of the concept of active use denial is that it is applicable only to facilities. To

make the concept fully effective, therefore, facilities protected by active use denial measures should be designed to produce proliferation-resistant fuel. The proliferation resistance of this material would, then, be limited by the considerations identified above.

9. Politically, it is clear that, even in the best of circumstances, nations will be reluctant to allow an international or multinational institution to render costly national fuel cycle facilities inoperative. The most realistic application for the concept of active use denial therefore appears to be as a means by which an international or multinational institution can inactivate a facility under its own auspices in the event of an impending national takeover. This application is worthy of serious consideration.

10. Institutionally, the implication of the above analysis is that active use denial is not a promising approach to supplant institutional means for providing improved proliferation resistance, but might usefully complement and strengthen particular institutional approaches.

IV. Concept Formulation and Evaluation

Background

1. Building on the identification of the various features of institutions, and their separate assessment in terms of proliferation resistance and acceptability, (Chapter II), this section of the study formulates and evaluates a spectrum of institutional arrangements. These are:

- An Association of National Fuel Cycle Undertakings
- Improved Safeguards
- Custody
- Multinational
- Global

In some cases more than one variant of each of the above classes of arrangement is considered. These classes have been selected to cover virtually the whole range of institutional arrangements, but the specific concepts formulated within each class have been designed, drawing on the generic assessments of Chapter II, to represent realistic and potentially attractive alternatives within their class. The methodology employed involves first reviewing the general rationale of each class of arrangement, then formulating and assessing one or more specific concepts.

Association of National Undertakings

2. This concept represents the least intensive form of institution studied. It would leave ownership, management,

and operation of sensitive facilities in national hands (although not precluding voluntary formulation of multinational enterprises), but would associate these national activities in an organization whose principal purpose is to adopt a code of nonproliferation conduct to be followed by participants. The London Suppliers Group falls within this concept, although the specific variants formulated in this study would have a more formal organizational structure, as well as other differences.

3. A basic thrust of the association concept is to seek to limit the number and geographic spread of reprocessing facilities beyond those included in the association as originally constituted. At a minimum, any additions would be limited to those which can be justified on the basis of economic need and acceptability of location. The association would attempt to achieve this limitation both by offering incentives; specifically, the assured availability of fuel cycle services from its members, and restraints; specifically, prohibitions on the dissemination of sensitive technology by any of its members. An association can also seek to accomplish other nonproliferation objectives. A particularly important one would be to ensure adequate protection of any plutonium returned to its customers, through requirements such as:

- safeguards and physical security protection for all distributed material.
- demonstrated near-term peaceful need for the product.
- submission of all recovered plutonium to an effective international storage, management, or custody arrangement, if available.

- use of proliferation-resistant technology in reprocessing, or the distribution of only proliferation-resistant products.
- confining the availability of its services only to those nations which accept a limitation on engaging in reprocessing themselves.

4. Associations may consist only of suppliers or they may include both suppliers and recipients. Inclusion of recipients would greatly strengthen the political legitimacy of the organization but would be difficult to achieve, given what would be viewed as the discriminatory nature of its main objective. The reluctance of recipients to participate, however, might be overcome if the benefits of participation were clear and substantial. These could include an assured source of reprocessing services and the resultant products.

Candidate Concepts

5. The principal candidate concept chosen for evaluation would have the following features:

- Membership -- initially, those countries with established reprocessing capabilities or large enough nuclear power capacity to justify such a capability.
- Code of Conduct calling for:
 - restraint on technology transfer;
 - limitation of services to countries which forego reprocessing, unless accepted by the association as economically justified; and
 - supply assurance arrangements for customers of the association.

A variant of this arrangement that is also examined would include recipients as well as suppliers in the Association's membership. To help accomplish this, supply assurances would be strengthened as much as possible, and perhaps offered exclusively to those recipients who become members.

6. From the nonproliferation viewpoint, an association of the type described would help limit the number and geographic spread of reprocessing plants, and favor their location in nuclear weapons states or the advanced industrialized nations. Since the association would have no central organ applying safeguards, or other materials control measures, the arrangement would not improve intrinsic resistance against such proliferation threats as diversion, seizure, and abrogation. However, the restraints on technology transfer, if successful in limiting the spread of reprocessing, would provide extrinsic nonproliferation benefits.

7. From the standpoint of acceptability, the association would entail little economic or operational inconvenience or expense on its members. On the other hand, it does not offer such benefits as economies of scale which might be available from other more intensive arrangements. Since the organization would have as one its founding principles the avoidance of economic collusion among the members it can be concluded that the association would not affect the basic economic or financial conditions of either suppliers or their customers. Politically, the association would impose relatively few constraints which might detract from its acceptability to suppliers. However, from the standpoint of recipients, participation would be equated with the acceptance of discrimination and acceptability would predictably be problematic. If the association were to be unacceptable to recipient suppliers, too, might be reluctant to participate. As a consequence, the viability of association might well depend on its success in attracting customer nation member-

ship, and this, in turn, could depend on the attractiveness of the benefits, such as improved assurance of reprocessing services, which the association might offer.

8. Against this mixed evaluation of acceptability must be weighed the limited nonproliferation effectiveness of the association. Thus, other institutional arrangements, involving control of sensitive material appear necessary. Consideration of the association concept is useful, however, in illustrating the importance of a code of conduct among reprocessing nations. This feature of an association could well be incorporated in more ambitious institutional arrangements.

National Facilities Under Improved Safeguards

Safeguards

9. Despite the key role of safeguards in nonproliferation policy, much of the present concern over proliferation risks stems from doubts as to the adequacy of safeguards. Consideration has, therefore, been given to how safeguards can be improved and how such improvements can contribute to the reduction of proliferation risks accompanying sensitive fuel cycle activities. In this analysis, the term safeguards is used in its conventional sense of a system to verify compliance with nonproliferation undertakings. The discussion focuses on safeguards as applied by the IAEA, but much of it would be equally valid for verification measures which could be applied by other international or multinational institutions.

10. Current reservations concerning the adequacy of safeguards center on:

- Technical effectiveness -- Whether safeguards can detect significant diversions promptly, unambiguously, and with a high degree of assurance.
- Scope -- Safeguards are not applied to all facilities and materials in all non-nuclear weapons states.
- Continuity -- The possibility that safeguards can be renounced or terminated, leaving sensitive facilities or materials transferred in reliance on safeguards no longer protected.
- Limited Purpose -- Safeguards are designed only to detect diversion, with their role in preventing proliferation dependent on the deterrent effects of detection.

These concerns, which differ considerably in their validity, importance, and potential for improvement, are examined below.

11. Repeated studies have led to the conclusion that the technical effectiveness of safeguards -- their ability to detect diversion -- can be made adequate at levels of safeguards effort which are reasonable in relation to the value of the materials involved and the power produced. The concern arises from whether, in practice, safeguards achieve this performance level.

12. Restraints of two kinds apply to the technical effectiveness of IAEA safeguards. These involve:

- Qualitative and quantitative restrictions on the Agency's right of access to safeguarded facilities and materials. Although the IAEA statute provides for "access at all times to all places and data and

to any person," these rights have become circumscribed in practice by the adoption of guidelines governing how this right of access will normally be implemented.

- Resources -- The personnel and financial resources available to the Agency for safeguards purposes are determined by action of the Agency Board of Governors, through the assessment of members, and are limited.

In addition to these restraints, the technical measures now being employed, which emphasize materials accountability, may not be optimized for the detection of diversion from sensitive facilities. Greater emphasis on containment and surveillance appears warranted.

13. Despite these restraints, there is little reason to believe that the system is seriously deficient in its detection capabilities. There is more reason for concern that resources allocated to it may be inadequate as additional sensitive facilities come under Agency safeguards. Renewed consideration should be given to modifying the method by which agency safeguards are financed by shifting some or all of the costs presently borne by the Agency to the nations which use nuclear power.

14. While the extension of safeguards to all facilities and material in a given country (full-scope safeguards) is obviously desirable and important, this step has no direct bearing on the effectiveness of safeguards in countering proliferation risks arising at any particular safeguarded facility. The continuity of safeguards, on the other hand, is of major significance in judging the adequacy of safeguards as an obstacle to proliferation. If countries have the right or

power to terminate safeguards, even on nuclear facilities, materials, or technology obtained in reliance on safeguards, the system would provide only limited assurance against proliferation risks.

15. Under existing policy, IAEA safeguards agreements with non-NPT parties require that safeguards remain in effect indefinitely on any material or facilities transferred under safeguards. However, agreements with NPT parties do not provide for continuity of safeguards in the event of NPT withdrawal, although the guidelines of the London Suppliers Group clearly call for such continuity. Consideration should be given to ensuring safeguards continuity for both parties and non-parties of NPT.

16. The most important issue concerning the adequacy of safeguards is their limited purpose as a mechanism for the detection rather than the prevention of diversion or seizure. A key concern is that even technically infallible safeguards capable of giving immediate warning of the diversion or seizure of sensitive material will not prevent this action, and will not afford sufficient time for effective diplomatic or other counteraction before nuclear explosives could be produced. This concern cannot be overcome by measures designed to improve technical effectiveness. Despite this limitation, there is good reason to make safeguards as technically effective as they can be within reasonable resource allocation.

Candidate Concept

17. On the basis of the foregoing analysis, the following approach to improving safeguards effectiveness has been chosen for evaluation:

- Relaxation or elimination of current restrictions on the frequency and intensity of IAEA inspection at the most sensitive facilities.
- Lifting of restrictions for ad hoc and special inspections.
- Improved funding of safeguards, including, if necessary, direct assessment of nuclear power generating countries.
- Clear establishment that safeguards are irrevocable for both NPT and non-NPT countries, at least with respect to equipment, materials, and technology supplied in reliance on safeguards.

18. The concept outlined above would materially improve the effectiveness of IAEA safeguards and would proliferation resistance, particularly to diversion threats. Nevertheless, the concept is not directly responsive to the concern that nations which divert or seize sensitive materials or facilities might be able, notwithstanding prompt and certain detection, to produce nuclear explosives before effective counter-measures could be applied.

19. With regard to acceptability, this concept would entail increased costs for both the inspectorate and the inspected facility or state. Despite predictable objections, there is convincing evidence that technically effective safeguards will not impose costs which significantly affect nuclear power economics. The acceptability of these costs, however, will depend heavily on other demands which are placed on inspected countries. If improved safeguards were the only, or the principal, measure called for to alleviate current proliferation concerns, it is likely that a number of countries would be prepared to accept the financial implications.

If, however, a number of other steps are required, the acceptability of substantially increased safeguard costs is far less certain.

20. A similar conclusion can be reached with regard to political acceptability. Safeguards have received broad international acceptance in a general sense, but virtually all countries attach importance to keeping the level of inspection activity as low as possible on political as well as economic grounds. Considerably increased inspection intensity could probably prove acceptable if this were regarded as the principal response in overcoming present concerns, but much less so if other stringent measures were called for. Another favorable political aspect is the fact that, unlike some other institutional approaches such as restrictive siting, safeguards can and should be non-discriminatory in their application.

21. The analysis of this section and the concept formulated for evaluation are focused on the safeguards system of the IAEA. However, much of the analysis would be applicable to verification measures undertaken by other international or multinational institutions. The creation of a new institution for the purpose of applying safeguards would seriously undermine the IAEA and would be internationally unacceptable. However, institutions created for ownership, management, operation, or materials custody of sensitive fuel cycle activities would almost certainly find it necessary to assure themselves of the proper use of facilities and materials under their jurisdiction. The analysis of this section provides a basis for formulating measures for this purpose.

International Custody of Sensitive Facilities and Materials

22. An institutional arrangement, designated "custody," which leaves ownership, managerial, and operational responsi-

bilities in national hands but establishes institutional control over material, has been given extensive consideration in this study. Such an arrangement would, in effect, extend the concept of international control contemplated for plutonium storage under the IAEA Statute to all sensitive facilities and materials throughout the back-end of the fuel cycle. In such an arrangement, sensitive material would be "born into custody" and would remain under this regime until rendered insensitive once again by reactor irradiation.

23. The rationale of the concept rests on the following principles:

- Material control, rather than such proprietary matters as ownership, management, staffing, and fuel cycle decision making has the most direct relevance to proliferation resistance.
- The assignment of proprietary responsibilities to an international or multinational authority is the most serious obstacle to the acceptability of institutional arrangements.
- Accordingly, most of the nonproliferation benefits of institutional arrangement can be secured, and their acceptability enhanced by confining the institutional responsibility to material control, while leaving proprietary responsibilities in national hands.

24. The material control responsibilities of such an institution would include:

- full control over the ingress and egress of sensitive material to and from the sites under its jurisdiction.

- exercise of this control through institution personnel, to the exclusion of any other authority.
- unrestricted right to account for, observe, and control material and the use of facilities for peaceful purposes within sites under its jurisdiction.

The totality of these rights is designated "custody." The extension of institutional control to all sensitive materials and facilities in the fuel cycle is central to the concept.

25. Custody can contribute to proliferation resistance in several important ways:

- Providing a nearly complete solution to the problem of undetected diversion by foreclosing the undetected egress of sensitive materials.
- Interposing a direct, although not invincible, obstacle to host country seizure, diversion, or abrogation.
- Changing in a fundamental way the political nature of any violation, thus deterring any attempt and making an effective response more probable and credible.

26. Custody would not, however, provide complete assurance that no violation would occur. Neither would it address directly the risks of technology transfer, although it would minimize these by avoiding compulsory international or multinational ownership, management, and staffing. It would include other barriers against proliferation risks, as appropriate. Qualitative and quantitative limitations on siting of sensitive facilities would remain important even if custody were established.

27. The concept of direct institutional control over material, while going well beyond verification safeguards, is gaining understanding and interest, as evidenced by discussions in INFCE and the IAEA Experts Group on International Plutonium Storage.

28. The incorporation of an element of physical control in the custody concept involves no conflict with a state's responsibility for "physical security." The physical security for which states are properly responsible involves protection of nuclear installations and materials against unauthorized acts by the state's own citizens or other parties acting in derogation of a state's responsibilities. Viewed in physical terms, the state's physical security responsibilities would be exercised from the perimeter of an installation outward. The institution's custodial responsibility would be exercised not against citizens of the state seeking access to a controlled facility or material, but in controlling movements of material which the state intends to carry out under its own authority. This institutional responsibility would be exercised from the perimeter of a controlled facility inward.

29. The requirement of institutional control over material movements does not preclude the possibility of concurrent control by the host state, sometimes referred to as a "two-key" system, provided that the veto power of the institution remains undiminished. However, if the facility involved provides materials or services to customers outside the host country, the two-key arrangement would require authorization by two authorities, and would probably, therefore, be less acceptable to non-host country participants.

30. The right of verification is an important back-up to control over material movement, since it provides added assurance against the existence of unknown pathways for

unauthorized removal of material. The verification authority of the institution, however, should be exercised in close coordination with IAEA safeguards to avoid unnecessary duplication.

31. The rationale for extending the custody arrangement to all sensitive facilities and material, including material in transit, rather than only to plutonium in storage, rests on several considerations:

- A large reprocessing plant can produce a quantity of plutonium several times the strategic threshold daily. Even if all this product is deposited immediately in a storage facility under custody, failure to place the reprocessing facility and the transport step under the same custody regime would mean that the transfer to custody would be under less effective nonproliferation control than the subsequent storage.
- Failure to apply custody to reprocessing facilities themselves also means that these facilities could be misused without interposition of the obstacles provided by custody. If these facilities were in different countries than those in which central stocks were located, failure to apply custody at the plants would be particularly undesirable.
- Application of custody at fabrication plants and at reactor sites whenever significant amounts of unirradiated fresh MOX fuel is present is also necessary to ensure nonproliferation protection equivalent to that provided central plutonium stocks. A typical commercial scale MOX fabrication plant would probably have an inventory on the order of several thousand kilograms of plutonium, and a single reactor reload

of MOX fuel would be of the order of several hundred kilograms of plutonium.

- Application of the regime to plutonium in transit is also necessary for similar reasons. A possible alternative would be limiting individual shipments to less than strategic amounts, but this could prove economically and technically impractical.

32. From the standpoint of composition, a custody institution could be either international or multinational. A set of multinational entities, each having an appropriate relationship with the IAEA, is viewed as preferable from the standpoint of both proliferation resistance and acceptability, for reasons which have been described in the generic assessment of institutional features. This approach would also enable the concept to be demonstrated earlier than would be possible if broad international agreement were required before custody institution could be established.

33. An important role for the IAEA would nevertheless be called for in a regime consisting of several multinational custodial institutions. The IAEA would, of course, continue to apply its own safeguard system, which would provide reassurance to its membership of the peaceful nature of the activities under the institution's auspices. It would also be desirable for the Agency to satisfy itself and its membership that each group possessed the requisite technical and political credentials and a suitable charter to undertake effective custodial responsibilities, in effect acting as an ad hoc licensor of such groups. A hybrid regime, in which the IAEA is responsible for central plutonium stores, while multinational institutions apply custody elsewhere in the fuel cycle is also a possibility.

34. Siting of the sensitive facilities under a custody regime could, in principle, either be left to each institution to decide, or be limited to as few countries as possible, making maximum use of an objective criterion such as economic need. Since custody does not constitute an infallible preventive against misuse, siting restrictions remain a desirable feature of custody institutions.

35. Release Criteria would be needed both to provide maximum assurance of legitimate and immediate peaceful use, and to ensure that appropriate releases take place without hindrance. Even when custody is extended to cover material until its insertion and irradiation in a reactor, release criteria would be employed to govern withdrawal from stocks. This would be a one-time release based on end-use, so as to eliminate any uncertainty that fabricated material could be used as intended. An important responsibility of a custody institution would be the verification both of intended end-use and that material was actually used as intended.

36. An important issue is whether release criteria should rule out particular peaceful end-uses, such as, for example, plutonium recycle in light water reactors. Such restrictions could be covered either by the criteria of specific institutions or addressed outside the institutional framework as part of a consensus on fuel cycle policy among the major nuclear countries.

Candidate Concept

37. The candidate concept for a custody institution formulated and assessed in this study would have the following features:

- A set of multinational institutions would be established independently of each other, with composi-

tion, technical competence, and ground rules subject to IAEA endorsement.

- Membership of each would include states with an adversary interest in ensuring nonproliferation by other members. At the same time, maximum political, economic, and security interdependence would be sought. Participants would agree to conduct sensitive activities or make use of sensitive materials only in accordance with the charter of the institution.
- Each institution would have full authority to control ingress and egress of material to and from controlled facilities and to verify compliance with these controls, without derogation of the IAEA's safeguards responsibilities. Control and verification would be implemented by a multinational staff responsible only to the multinational political direction of the institution.
- Facilities and materials within sites at which custody is in force would normally remain under national ownership and management, and national authorities or private parties authorized by them would retain full authority for fuel cycle decisions. However, the voluntary association of two or more members of the institution in the ownership, management, or staffing of a facility would not be ruled out, and might be encouraged.
- Transfer of any material under custody of the institution to either members (including the host country) or non-members would be subject to agreed release criteria to provide maximum assurance of an immediate, legitimate peaceful need.

- In the preferred variant of the arrangement, each group would include both suppliers and their customers, and the institution would develop back-up arrangements to provide assurances of supply to all recipient members.
- The group would also adopt ground rules limiting the transfer of sensitive technology.
- Funding would be derived from the membership of each institution, relying primarily on surcharges applied to materials or services delivered.
- Custodial authority, in the preferred variant, would extend to material up to the time of its insertion into a reactor. Fuel fabrication would be co-located with reprocessing and fabricated fuel would be transferred only when immediately needed.
- As a less desirable alternative, custody might not extend beyond the perimeters of controlled facilities, but the institution would have the right to verify the prompt insertion of any transferred sensitive material. Shipment of material in proliferation resistant form might also be considered.

38. The institution described above would strengthen the proliferation resistance against national diversion, seizure, and abrogation by providing both improved detection capabilities, a physical obstacle against unauthorized movements, and a greater likelihood of prompt and effective counter-action against any violation. It would also, through its code of conduct, provide improved protection against transfer of sensitive technology.

39. In terms of economic and operational acceptability, the institution would not entail substantial operating costs. More importantly, it would not mandate organizational forms which might be, or might be perceived as, less efficient than national facilities. In short, the institution does not impose any of the inefficiencies which might accompany multinational ownership, management, or operation, but neither does it preclude any of their benefits, such as economies of scale, if the participants choose to join in such activities. In light of its nonproliferation advantages, such an institution may have a cost: benefit ratio more favorable than any of the other institutional alternatives considered in the study.

40. Politically, the concept involves a major change in the nonproliferation regime as it now exists. Nevertheless, the changes are less drastic than other approaches, such as multinational or regional fuel cycle centers, in which ownership, management, and operation, in addition to material control, are internationalized or multinationalized. The custody concept also enjoys the advantage of being based upon a principle which is already incorporated in the IAEA Statute. Objections can be expected over the presence of multinational custodians who would exercise authority over material movements even by the host country, but these same objections would apply both to plutonium storage arrangements under the IAEA and to other more intensive forms of multinational fuel cycle institutions.

41. There may also be concern that the custody arrangement reduces energy security by giving a multinational authority control over national access to a valuable energy resource. To counter this concern, the arrangement should be constructed with strong guarantees that states in full compliance with all relevant undertakings will receive the materials and services to which they are contractually entitled. The fact

that the arrangement would be non-discriminatory, with host country access being controlled to the same extent as that of other members, would be a positive factor. In the final analysis, the composition of the institution may have a decisive influence on acceptability.

Multinational Ownership and Management

42. Multinational ownership and management of sensitive facilities has attracted the attention of nonproliferation policymakers from the outset of the nuclear era, and is the form of institutional arrangement most commonly implied when such arrangements are discussed in general terms. These arrangements constitute another alternative in seeking a compromise between unrestricted national control of sensitive facilities and materials and their avoidance. An important objective of this analysis is to determine the incremental costs and benefits of such arrangements in relation to the custody concept.

43. As in the case of nationally owned facilities under international or multinational custody, multinational ownership does not provide infallible protection against the proliferation risks of diversion, or host-country seizure or abrogation. Moreover, it presents greater risks of technology transfer, although these risks will depend on the exact nature and degree of multinational participation in management and operation. Multinational ownership arrangements can, however, offer greater benefits than custody alone in limiting the number and location of sensitive plants.

44. In terms of acceptability, multinational ownership and management involve complex considerations, which work both for and against acceptability. In the most general terms, such arrangements tend to be viewed as encroaching on

national fuel cycle decisional authority and entailing increased management complexity. However, for many countries with limited markets and limited technological and financial resources, participation in a jointly-owned fuel cycle facility may be the only realistic means of engaging in the activity in question.

45. Multinationalization of the ownership of reprocessing plants alone would offer little in the way of nonproliferation benefits. To be effective, multinational ownership of reprocessing, like custody, would have to be coupled with an international plutonium management regime to reduce proliferation risks connected from the storage, release, shipment and use of plutonium produced in the multinational plants. For reasons explained in the preceding section, such a regime should be based on the concept of multinational custody. Verification alone would not provide the desired level of proliferation resistance. Such an extended custody regime could be applied either by a single international organization (the IAEA itself or a specialized agency under its auspices) or by each multinational ownership institution with respect to the material and services it provides.

46. Siting is of particular importance to the ability of an ownership institution to reduce proliferation risks. The same siting alternatives -- nuclear weapons state or stable neutral states -- are as preferable for multinational ownership as they are for custody, and are subject to the same questions as to political acceptability. A realistic alternative is to determine near-term siting by placing existing reprocessing facilities under multinational ownership, with any new construction geared to economic need.

47. Composition is also important to the performance of ownership institutions. The same criteria -- adversity of nonproliferation interests and interdependence of other inter-

ests -- are as important to ownership institutions as to custody institutions. The inclusion of nuclear weapons states or industrialized supplier states in ownership institutions would be desirable. Technical and managerial competence on the part of the host-country and, perhaps, other key participants is of particular importance in an ownership institution, since such institutions necessarily involve the operation of plants to serve a multinational market.

48. A particular concern with multinationally owned and managed facilities is the risk of undesirable technology transfer. This consideration requires attention to whether such facilities should be multinationally staffed. Multinational staffing is desirable both to provide built-in diversion detection capability and to minimize complaints of discrimination from less industrialized members of the institution. On the other hand, multinational staffing will entail wider dispersion of technology. There is little reason to doubt that sufficient information concerning reprocessing is in the public domain to allow most if not all countries engaging in nuclear power generation to build a small facility for the separation of plutonium from irradiated fuel. However, hands-on experience in a commercial reprocessing plant could accelerate and increase the assurance of success of such an effort.

49. Several alternatives are available to minimize the risks of undue technology transfer without total exclusion of particular participants, a course of action which would severely limit the political acceptability of ownership arrangements without offering commensurate gains in proliferation resistance. These alternatives include:

- limiting access to design and construction information while allowing participation in operations;

- controlled involvement in operations to protect information deemed to be most sensitive.

50. Another area of particular importance for ownership institutions is that of fuel assurances. By enabling a number of countries to participate in the ownership of a fuel cycle facility, ownership institutions may provide a more credible assurance of supply than would nationally owned facilities. The counterpart of this, however, is that supply assurances must be strongly expressed and strictly observed. Additionally, such institutions must undertake to expand plant capacity to meet new requirements.

51. The inefficiencies, real or perceived, of multinational management constitute one of the strongest bases against the acceptance of such arrangements. Two-tiered management structures are one way of minimizing political interference in management decisions. Such systems, if carefully structured, can also give non-operating equity participants a role in overall decision making which would serve to mitigate distinctions among different classes of members.

Candidate Concept

52. The candidate concept for multinational ownership institutions would have the following characteristics:

- Initial siting would be confined to existing plants, to the extent possible. Alternatively, siting would be limited to nuclear weapons states or stable countries not involved in regional disputes.
- Multinational management and restricted multinational staffing would be employed. Technology relating to design and construction would not be shared with countries not already in possession of such information. Broader sharing would be considered on a

case-by-case basis, geared to the need for new capacity.

- Strong assurances of supply of the institution's services would be extended to all participants. Release of plutonium fuels would take place through an international plutonium custody regime, if available, or in its absence, under terms and conditions established by the institution.
- Facilities would be under the custodial authority of the institution.
- Operational authority would be separated from political control by a two-tier organization.
- Participants would agree not to autonomously engage in the activities undertaken by the institution. Consultation would take place to agree on need and timing of expansion to meet new requirements.

53. In terms of proliferation resistance, the ownership institution described above would not provide absolute protection against diversion or national takeover, but would be markedly superior to the existing safeguards regime. It would have somewhat greater resistance to these threats than custody alone, due to the added deterrent effect of joint ownership, but this difference is not likely to be a large one. Although there has been growing acceptance in recent years of nationalization or expropriation, this acceptance may well not extend to the nationalization of multinational nuclear facilities. Such a distinction would arise, however, not from proprietary considerations, but from the unique relationship of nonproliferation undertakings to international peace and security. Given this fact, it would appear that the undertakings involved in a custody arrangement would enjoy a similar presumption of inviolability.

54. If accompanied by a significant level of multinational staffing, the ownership institution could offer high detectability of diversion at less cost and intrusion, in terms of personnel resources required for this task, than a custody arrangement. However, the custody arrangement could be designed to achieve comparable levels of detectability through effective verification by its multinational custodial force. To the extent that this is accomplished, the difference in risk of unwanted technology transfer between ownership and custody arrangements would probably not be great, but would still likely favor the custody arrangement.

55. In terms of acceptability, the differences between the two arrangements are more complex. Ownership arrangements would probably be favored by countries which are not likely to be host nations for the institution's facilities in the foreseeable future. Joint ownership will give these countries a voice in fuel cycle decisions that they would not otherwise be likely to have, and, depending on the institutions policies, improved access to technology and hands-on experience. These benefits, however, would not be available without cost, and such countries could feel that their investment bought very little, particularly if they were minority investors or if the institution placed them in a class of membership which enjoyed less access and participation than that accorded technology suppliers.

56. Custody institutions would almost certainly be preferred by large industrialized countries able to build and operate facilities on a national basis. Custody could be acceptable, if not preferable, to less advanced participants if the overall arrangement offered strong fuel assurances, diversified sources of supply of the services in question, and reasonable opportunities to host new facilities if and when their economic need made this a reasonable step.

57. In summary, while the ownership concept has some advantages in proliferation resistance over custody alone, these do not appear to be compelling. The acceptability distinctions are more difficult to characterize and might be positive or negative. Much would depend on the specific ground rules of the specific institutions and the specific composition expected. It appears that a reasonable approach continues to be making multinational ownership, management, and operation permissive, but not compulsory, features of institutions for sensitive fuel cycle operation.

Global Institution

58. The distinguishing feature of the global authority is its composition, one which would be designed to include at least all suppliers and users of the particular services and materials dealt with by the institution. A global institution might also, as does the IAEA, include many other countries not currently involved in either the supply or use of these services or materials. The institution could cover one or more functions, ranging from improved safeguards or the promulgation of a code of conduct at one extreme, to ownership management and operation of facilities at the other. It could also deal with one or more steps of the nuclear fuel cycle. If a global institution could be created, it would be logical, although not essential, that it cover the entire nuclear fuel cycle, both front-end and back-end.

59. Previous sections of this chapter have dealt with institutions which adopt codes of conduct, apply improved safeguards, and apply custody to sensitive facilities and materials. The application of safeguards is already the responsibility of a global institution -- the IAEA -- and is not further analyzed in this section. While the analyses of institutions for the application of codes of conduct and of custody emphasized multinational organizations, much of these analyses are

equally applicable to global institutions performing these functions. The remainder of this analysis is devoted to global institutions for the ownership management and operation of sensitive fuel cycle facilities. Although such institutions are in some respects an extension of the multinational institutions considered in the preceding section, the analysis of this section indicates that substantially different issues are presented by a global institution.

60. The global authority considered in this section would encompass several of the functions already considered in earlier sections. It would adopt and apply a code of conduct concerning dissemination of technology; it would control and apply custody to the sensitive facilities and materials under its jurisdiction, including the application of verification measures as needed to ensure the effectiveness of its control and custody; and it would own, manage, and operate all facilities required to provide the services and materials under its jurisdiction. In this regard, variations in ownership and management patterns are possible; for example, host countries might be allowed to hold larger proportions of ownership in the facilities in their territory (as in the case of Urenco) provided this does not derogate from the institution's major responsibilities. The institution would probably cover both enrichment and back-end fuel cycle activities, since this would enhance its ability to provide fuel assurances and thus its potential acceptability.

61. In principle, a global authority might be able to provide proliferation resistance beyond that offered by multinational ownership institutions in three respects:

- The universality of the approach might increase pressures on reluctant nations to participate, beyond the pressures which could be exerted by multinational undertakings.

- The supply assurances of the global authority may inspire greater confidence and thus more effectively discourage independent national programs.
- The risks of a segmented market, in which some suppliers offer services with less stringent nonproliferation conditions, would be reduced to the extent that the institution is successful in achieving universality.

62. In contrast to these advantages, a global authority would be far more difficult to construct than a set of multinational institutions. Moreover, its broad membership could dilute the assurance and effectiveness of its response to violations, and thus its deterrent capability. Response could well be dependent on the identity of the violator and the current international political standing of the country concerned.

63. Both formation and subsequent operation of a global authority would present formidable obstacles. These include:

- To achieve universality, the concept requires as an initial or early step the acquisition of existing facilities. This could require large financial resources and difficult and potentially unpopular decisions by countries which have already successfully deployed the facilities in question. Agreement on investment shares, voting rights, and related matters would be extremely difficult to achieve.
- The wide diversity and large number of participants would create unprecedented problems of management, staffing, and operation, which could probably be overcome only in part through two-tier or lead-country organizational concepts.

- Built-in conflicts would exist with regard to pricing and related commercial considerations, with users generally favoring lower prices and suppliers favoring higher prices. Although internalized, decision making in these areas would be difficult.

Candidate Concept

64. Principal features of the global authority considered in this analysis include:

- Provision of both front-end (enrichment) services and back-end fuel cycle services to enhance supply assurances.
- International ownership of facilities, with lead-country management and operation.
- Inclusion of existing reprocessing facilities as an early step, and construction by the institution of all future ones.
- Provision of materials and services on the basis of full cost recovery, with strong commitment to meet all demands.

65. The global authority described above would offer strong proliferation resistance, but as in the case of concepts considered in earlier sections, this resistance would not be absolute. Diversion, and host country takeover or abrogation would continue to be possible. In view of this, facility siting would continue to be a relevant problem, and the authority would face the difficult issue of whether to follow a policy of restrictive siting or seek to employ broadly diversified siting and strong material controls as an alternative. The mere creation of a global organization would not elimi-

nate the need for actual physical custody of sensitive facilities and materials to provide strong diversion detection capability and a physical and political barrier to seizure or abrogation. Technology transfer would be difficult to suppress in an institution of global composition.

66. Whether such an institution would provide improved proliferation resistance in comparison with a multinational ownership or even a multinational custody arrangement is open to serious question. On the face of it, a violation of non-proliferation undertakings and the control system of a global institution might be regarded as an even more serious transgression than a similar violation of multinational undertakings. Despite this, the ability of the global organization to respond as effectively as might a smaller multinational body is subject to doubt.

67. In terms of acceptability, problems of financing and finding acceptable financial formulas would be comparable to those of a multinational ownership institution, but even greater, in view of the number and diversity of participants. Demands for participation in contracting, procurement, and jobs are foreseeable, and are not subject to easy resolution. The absence of competition would have unforeseeable but probably undesirable effects both on the institution's performance and on the development of generally acceptable pricing policies.

68. The lead-country approach of the candidate concept would offer the best chance of minimizing the operational difficulties posed by a global institution, but would present major problems of political acceptability. While the approach would be favored by host countries, non-host countries would question whether the approach is consistent with the broad international character of the institution. Neither the lead-country approach nor two-tiered management arrangements

would insulate the operation from major questions of economic and commercial policy.

69. Politically, the issue is whether the global authority offers sufficiently improved proliferation resistance to attract support, given its major problems of political acceptability. These include:

- Elimination of a competitive market and diversity of suppliers for important fuel cycle services.
- Surrender of national authority over fuel cycle decisions in favor of an institution in which each participant's influence is even less than in a multinational body of limited membership.
- Prospects for a highly political approach to any issues which arise because of the inclusion of both suppliers and recipients, many of whom lack the affinity that might exist in a carefully structured multinational body.
- Possible domination by developing countries which place greater emphasis on equality of treatment than on nonproliferation.

These and previously mentioned problems lead to the conclusion that a global institution for the ownership, management, and operation of sensitive fuel cycle facilities has few if any nonproliferation advantages over multinational ownership or custody institution, and would face considerably stronger opposition.

V. Implementation of Institutional Concepts

1. The implementation of institutional arrangements involves selection of the particular types of arrangements to be employed, identification of the prospective participating countries, the fuel cycle steps to be covered by the arrangement, and the means by which participation can be brought about.

In practice the implementation process would be a lengthy and complex one, requiring the formulation of detailed negotiating tactics, which are not an appropriate matter for consideration in this study.

2. In light of the conclusion of the preceding sections, the institutional concept given principal emphasis was custody. However, the custody concept selected does not preclude voluntary formation of multinational ownership arrangements.

3. The principal criteria governing implementation are the same as those applicable to concept evaluation itself: the nonproliferation effectiveness of the arrangement and its acceptability. However, there are several additional criteria which govern when and how implementation should be attempted. These are:

- Applicability to existing facilities.
- Maximum involvement of sensitive countries.
- Suitability for expansion of membership, without stimulation of undesirable sensitive facilities.
- Appropriate composition.

4. While the evolutionary approach to improvement of the nonproliferation regime is appealing and reasonable, the

evidence suggests that specific institutions, once created, cannot be readily upgraded in their authority to apply non-proliferation measures. Thus, there is a strong rationale to create institutions which possess the desired functional authority from the outset. On the other hand, there is good reason to believe that institutions, once created, can be expanded by the addition of new members. This suggests that it is preferable to create institutions capable of doing what is needed, and seeking additional membership as time goes on, rather than watering down institutional capabilities to attract a maximum initial membership. This is the approach successfully followed in the case of the NPT.

5. While emphasis has been placed on custody, an association for the application of a code of conduct is also an important need. Incorporation of this concept in a custody institution would be the preferable course of action (as postulated in the candidate custody concept), but there is considerable doubt as to the acceptability of a code of conduct restricting technology transfer in an organization in which consumers as well as suppliers are members. A possible alternative is creation of a separate association of suppliers to establish a code of conduct, as in the London Suppliers Group.

6. A central consideration in the implementation of any institutional arrangement is the incentives and leverage available to encourage participation. These fall into two categories: intrinsic incentives, resulting from benefits offered by the institution itself; and extrinsic benefits or leverage, originating outside the institution. Every effort should be made to maximize intrinsic incentives.

7. Intrinsic incentives include nonproliferation benefits themselves, fuel assurances, and the legitimization of fuel cycle policy. Possible extrinsic benefits include nuclear assistance external to the institution, non-nuclear assistance, diplomatic support, and security cooperation. Except

in unusual instances, granting or withholding security support would not constitute a credible inducement to bring about participation in a fuel cycle institution. In general, the feasibility of using extrinsic inducement is heavily dependent on overall political considerations.

8. The basic alternatives available in terms of grouping countries are:

- A single institution, in which all concerned countries would participate, although not necessarily from the outset.
- A set of multinational groupings.

For reasons explained in the preceding chapter, a set of multinational groups may be preferable to a single institution from the standpoint of both nonproliferation effectiveness and acceptability. The analysis of this section suggests that this approach also has advantages in terms of the implementation criteria outlined above and, in particular, the desirability of an early start.

9. If a multinational custody institution is successfully established, a possible outcome is that most interested countries would seek to join this group in preference to establishing a separate one. If events follow this course, there is no compelling reason to foreclose this outcome, despite the advantages seen for separate institutions. In any event, there is no need to make a definitive choice. Additional institutions could be created if it becomes clear that important countries would not join the initial group.

10. The relationship of multinational custody institutions to the IAEA requires careful consideration throughout the implementation process. In addition to its indispensable

role of applying safeguards, the IAEA can play an important role in ensuring the nonproliferation bona fides and observance of minimum nonproliferation standards by each custody group through appropriate relationship agreements. If the IAEA is successful in establishing an international plutonium storage arrangement, this arrangement should displace the custody regime in so far as central plutonium stores are concerned. Finally, if a single custody organization evolves, it could become a specialized arm of the IAEA itself.

11. An attractive starting point for the establishment of a custody group is offered by the small- to medium-scale reprocessing facilities already in operation in several countries. Basing a group on these facilities would have the advantage of offering an early start while avoiding some of the commercial sensitivities which might accompany immediate efforts to encompass full-scale commercial facilities. In effect, this approach would make possible an early demonstration of the feasibility of the custody concept without requiring a full-scale commitment by the countries concerned. This is analogous to the early application of Agency safeguards to selected U.S. facilities that played a valuable role in gaining wide acceptance of safeguards by demonstrating their effectiveness and non-intrusiveness. An institution based on small-scale facilities could well become the nucleus of a broader group that would include the large-scale reprocessing facilities already in operation or planned.

12. Additional groupings are possible and might be desirable to accommodate particular circumstances affecting only a few countries.

13. The candidate concept for custody calls for participation by customers, as well as suppliers, of reprocessing services, and this approach is clearly preferable to institutions in which only suppliers participate. In the latter case, customers would still be required to accept the custodial

arrangement over material delivered to them, without any role in the management or operation of the institution.

14. The expansion of institutions by the addition of new members should take place in accordance with clear criteria for the acceptance of additional host countries. Such criteria should limit new host countries to locations where national needs have reached economic levels.

VI. Analysis of Model Institutions for Existing Facilities

1. The introduction to the above study stated that there were two parallel tracks in this project. The other "track" of the project involved an effort to address the same basic problem of identifying proliferation resistant institutions for the back-end of the fuel cycle, but from a different perspective. The approach taken in this track was to define two model options in high detail, going beyond the categories of institutional features in the systematic study to consider such points as institutional charter, host country-institution relations, audit and regulatory arrangements, and pricing policy. This approach assessed these model options from the standpoint of their international negotiability (acceptability) and proliferation resistance (effectiveness), and synthesized the results for the purpose of suggesting institutional strategy.

2. Model Option #1, the monolith, was a multinational, monopolistic, cooperative institution which (1) would be responsible for establishing and implementing nonproliferation measures, for carrying out all back-end supply and service functions, and owning and operating all related facilities, (2) would have a Board of Governors authorized by treaty and charter to serve the nonproliferation and supply interests of those nations participating in ownership, (3) would be owned through appropriate national mechanisms by all nations with supplier or buyer interests in the supply and service functions, and (4) would be run as a corporation and would be responsible for the proper conduct of its supply and non-proliferation activities.

3. Model Option #2, the "club," is oriented toward augmenting existing institutional arrangements (specifically the London Nuclear Suppliers Group and the IAEA) so as to tighten some

existing loopholes and improve the credibility of these arrangements. Effort is made to keep the degree of necessary international interaction low. By multilateral agreement, countries with the largest nuclear complexes and current or prospective reprocessing facilities (i.e., the U.S., U.K., France, F.R.G., Japan, and possibly the U.S.S.R.) would agree to: set up guidelines for licensing their subnational units (commercial entities) to deal in specific nuclear materials; create an oversight council to interpret the treaty in the form of rules; and appoint the IAEA to verify that nations are complying with the rules. The primary institutional arrangement is a set of guidelines in which the parties agree not to transfer technology beyond group members; to ship only sealed, spiked, fabricated fuel elements; to abstain from collusion to restrict markets, quality of service, or price -- beyond those restrictions relating to nonproliferation as specified in the guidelines; and to impose economic sanctions for certain forms of non-compliance. The IAEA (or possibly another agency) would inspect fuel elements at all transfer points and certify the integrity of the fuel, inspect facilities, and audit contract and financial records.

4. These models were chosen, in collaboration with the sponsoring organization, to define the end points of a spectrum on which the two institutions in question vary in terms of scope of membership, degree of centralization, time needed to establish, and degree of institutional change required relative to the status quo.

5. The assessments of these models concluded that the most significant nonproliferation gains would be achieved through restrictive siting, international control of sensitive materials, postponing decisions to reprocess, and strengthening sanctions, and that either model institution could be designed to provide these benefits. Consequently, the assessment identified negotiability as the primary criterion for choosing between them.

6. The strategy indicated by this analysis would employ a club-type concept as a near-term stop-gap measure, while efforts would be made to develop the monolith for the purpose of achieving long-term institutional stability. Moreover, it was concluded that negotiations for the establishment of the monolith should begin at an early date in light of the time necessary to implement this concept. Among the first step suggested in this regard were international spent fuel storage and control of sensitive material, international cooperation on high level waste disposal R&D, and international breeder cooperation.

7. A draft report of the second track study was transmitted to the sponsoring organization in January, 1979. The client determined that this track of the study had served its purpose, that further work on the draft was unnecessary, and that the remaining effort should concentrate on completion of the other track and of the analysis of implementation.