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SAFEGUARDING A DOMESTIC MIXED OXIDE INDUSTRY AGAINST A HYPOTHETICAL SUBNATIONAL THREAT

Executive Summary

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FOREWORD

This document is a staff technical report. The Commission has not specifically addressed many of the policy issues in the specific context of this report, and has, therefore, not approved its conclusions. The Commission has authorized publication because it believes that the information should be available to the public.

The content of this report is current as of mid-1977 and was originally intended to provide the basis for a supplement to the generic environmental impact statement (NUREG-002) on the use of recycle plutonium in mixed-oxide fuel for light water reactors (GESMO). Its content focused on the feasibility of safeguarding a domestic U.S. mixed-oxide industry. The issues of international safeguards, the possible effect of a domestic mixed-oxide industry on international considerations, and any influence on international nuclear proliferation were beyond the scope of this report.

Prior to completion and publication of this document as an environmental impact statement, President Carter, on April 7, 1977, announced some of the conclusions he had reached following a thorough review of nuclear power issues. The issues raised by the President's statement were sufficiently fundamental to cause Commission reassessment of the course being followed with respect to GESMO. As a result of the reassessment, which included consideration of public comments and the views of the Executive Branch, the Commission announced termination of the GESMO proceedings in 42 FR 65334.

While directing the termination of the GESMO proceedings, the Commission recognized the value of making the results of the effort devoted to the study of safeguards issues available to the public. Accordingly, the NRC staff is providing such information with its publication of this document as a technical report. Thus, the information contained herein becomes publicly available for use in addressing nuclear power issues. Any questions or comments on this document should be referred to the Director, Division of Safeguards, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

EXECUTIVE SUMMARY

1.0 BACKGROUND AND OVERVIEW

To aid in assessment of the proposed wide-scale use of mixed-oxide (MOX) fuel in light water nuclear reactors, the Atomic Energy Commission prepared and circulated a draft environmental impact statement in accordance with the National Environmental Policy Act of 1969. That draft statement entitled "Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors" (GESMO), was issued in August 1974.

In response to comments received, particularly from the President's Council on Environmental Quality, a decision was made by the Nuclear Regulatory Commission (successor to the Atomic Energy Commission in the regulation of the domestic nuclear industry) to proceed with preparation of a final document on the Health, Safety, and Environment portions of the GESMO and to prepare a new draft document on the Safeguards portion. This step was taken in order to assure a full assessment of the safeguards issues before reaching any decision on the wide-scale use of MOX fuel. Accordingly, in October 1975, while the final GESMO document on Health, Safety, and Environmental matters was in preparation, an effort on a Draft Safeguards Supplement was initiated. Publication of an overall cost-benefit analysis was deferred pending issuance of the Draft Safeguards Supplement.

The final version of the Health, Safety, and Environment portion of the GESMO was published in August 1976 as NUREG-0002. Evaluation of five fuel cycle alternatives is presented in that document on the basis of health, safety, and environmental--but not safeguards*--effects. The principal findings were as follows:

- The safety of reactors and fuel cycle facilities would not be significantly affected by recycle of fissile materials.

- Nonradiological environmental impacts resulting from a fuel cycle involving recycle of fissile materials from spent fuel would be slightly smaller than those from a fuel cycle without recycle.

- Plutonium recycle would extend uranium resources and reduce enrichment requirements, while requiring the reprocessing and fabrication of plutonium-containing fuels.

- While there are uncertainties, widescale recycle would probably have an overall economic advantage relative to a fuel cycle without recycle.

- Differences in health effects attributable to recycle are too small to provide a significant basis for choosing among fuel cycle options.

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*MOX industry safeguards are defined as those measures employed to prevent the theft or diversion of plutonium or plutonium compounds or the sabotage of MOX facilities or shipments.

- No waste management considerations were identified that would bar recycle of uranium and plutonium.

The safeguards implications of the MOX fuel cycle stem from the introduction into the commercial nuclear power industry of substantial quantities of strategic special nuclear material (SSNM)* as compounds of plutonium. The primary concern about plutonium is its potential for use by malefactors in a nuclear explosive or a radiological dispersal weapon. This document addresses those issues and was prepared in response to the NRC directive calling for a new Draft Safeguards Supplement for the GESMO.

Any decision on the wide-scale use of MOX fuel will include an overall cost-benefit analysis which will require weighing the potential societal benefits and the risks from such use. To that end, this report illuminates the factors which affect the risk-benefit balance, including new or incremental risks or additional burdens to society stemming from the safeguards system needed to protect a wide-scale MOX industry. The cost of safeguards systems, estimated in this document, represents a basic input into the overall cost-benefit analysis of the wide-scale use of MOX fuel. Finally, this document responds to the views on safeguards expressed by the President's Council on Environmental Quality and to public comments on the draft version of NUREG-0002.

In performing the assessment of safeguards for the wide-scale use of MOX fuel, answers were sought to three basic questions:

- What would be the potential incremental risks to society from malevolent acts directed at introducing additional quantities of plutonium in the commercial sector?**

- Could MOX in wide-scale commercial use be sufficiently well protected, under the concept of continued civil order, to assure that the risks to society from malevolent acts would be acceptably low?

- If adequate safeguards could be provided, would their economic and other societal impacts (i.e., on civil liberties, laws, institutions, physical environment, etc.) be acceptable?

*Special nuclear material (SNM) is defined as plutonium, ^{233}U, or uranium enriched in the isotope 235. Strategic special nuclear material (SSNM) is any SNM from which a nuclear explosive can be fabricated. This includes plutonium, ^{233}U, and uranium enriched 20% or more in the 235 isotope.

**For the purposes of this report, the "commercial sector" was interpreted to mean within the United States. There are, of course, substantial international implications and potential risks with respect to nuclear arms proliferation which must be addressed before a final decision is made on reprocessing and the continued development of reprocessing technology. These important international considerations will not be discussed herein, because other Government agencies with direct responsibilities in this area, namely, Department of Energy (DOE), the Arms Control and Disarmament Agency, and the Department of State, are studying the implications of reprocessing on nuclear arms proliferation.

To answer the first question, regarding risks from malevolent acts, it was necessary to consider: (1) the characteristics of the nuclear industry and nuclear materials which exist in the United States and the changes which would be caused by the projected MOX fuel cycle industry; (2) the potential threats to that industry; and (3) the consequences if safeguards failed and a threat were successfully carried out.

A multi-step approach was used to answer the second question, whether a commercial MOX industry in the U. S. could be adequately safeguarded. First, it was necessary to analyze the protection already given to other forms of SSNM and to study the additional safeguards systems and equipment currently available for use. Then these elements were combined into a conceptual design of a safeguards system for the MOX industry. Finally, possible alternatives to this conceptual design were considered.

The third question, related to the economic and societal impacts of MOX safeguards, was addressed by comparing the burdens created by a mature MOX industry with those of an industry without recycle.

Consideration of these three questions and related issues resulted in the following principal findings:

- Use of MOX fuel would have no significant impact on the potential consequences of sabotage to nuclear reactors.

- Risk to society could exist if threats to the MOX fuel cycle industry materialized and adequate safeguards were not provided.

- By building on extensive and highly successful U.S. experience in safeguarding SSNM utilized in defense programs, in civilian (DOE) research and development, and in commercial applications, safeguards systems can be designed to protect a future MOX industry to an extent that limits the risk of theft and malevolent use of plutonium to a level believed acceptable to the public.

- The incremental burdens to society from the imposition of appropriate safeguards would consist principally of relatively small increases in MOX industry costs and in the number of individuals affected by plant security and safeguards systems. These burdens would be a minor extension into the commercial sector of those already borne in safeguarding SSNM in military and energy R&D programs.

Additional details with respect to these findings are summarized below.

2.0 POTENTIAL RISKS TO SOCIETY

The major risk to society from the wide-scale use of MOX fuels arises from the possibility that significant quantities of plutonium could, through theft or internal diversion, fall into the wrong hands and be used for fabrication of an illicit nuclear explosive or plutonium dispersal device. A lesser risk is that SNM could be dispersed through acts of sabotage. Assessing these risks requires consideration of: (1) the present uses of SSNM in commercial and Government-related industries and in the projected MOX industry; (2) potential threats to the projected MOX industry; and (3) the consequences of a successful malevolent action against that industry.

Many commercial nuclear fuel cycle facilities (eleven at present) licensed and regulated by the NRC currently handle significant quantities of SSNM. In total, the 11 facilities have a potential inventory of greater than 20 metric tons of SSNM, most of which is high-enriched uranium used in Government-sponsored fuel cycle programs. A mature MOX fuel industry would, by the year 2000, add approximately 20 commercial nuclear fuel cycle facilities and an additional inventory of SSNM in the forms of MOX and PuO_2. As indicated in Table ES.1, the plutonium inventory for a MOX fuel industry projected for the year 2000 would be 77 metric tons of the element in PuO_2 and MOX forms. Such an industry, if permitted to grow without geographical constraints, would involve approximately 2,400 shipments per year of PuO_2 and MOX.

TABLE ES.1

PROJECTED SSNM INVENTORY AT NRC-LICENSED FACILITIES
(Metric Tons)

Type of SSNM	Present	1980	1985	1990	1995	2000
High-enriched uranium[a]	>20	>20	>20	>20	>20	>20
Plutonium, metal equivalent, in various forms[b]	1	3	13	39	54	77

[a]Assumes no major change in the size of the programs which currently utilize high-enriched uranium.

[b]Approximately 20% of this quantity would be in the form of plutonium oxide. The remainder would be in plutonium concentrations of less than 10%, primarily MOX fuel. See Section 3.2.6.

In addition to the more than 20 tons of SSNM presently being handled by NRC-licensed facilities, much larger quantities have been handled in the U.S. nuclear weapons program, and additional material is being processed by other nations in their nuclear weapons programs and in their growing nuclear power industries.

With respect to the fabrication of a nuclear explosive (the greatest potential risk from a successful theft or diversion of SSNM), the high-enriched uranium (HEU) now being safeguarded under NRC authority and the HEU and weapons-grade plutonium controlled by DOE would be as useful to an adversary as the reactor-grade plutonium oxide envisioned with wide-scale use of MOX fuel. Accordingly, the primary incremental risk to society introduced by the wide-scale use of MOX fuel would arise not from any fundamentally new problem but from the increased quantities of SSNM available within the commercial sector. The fact that reactor-grade plutonium oxide, unlike HEU, can be used as a radiological dispersal device introduces an additional incremental toxic risk.

Although the potential threat against nuclear facilities cannot be precisely defined, the following conclusions were re[illegible] regarding possible threats:

- There are people who have the skills necessary to steal SSNM and fabricate a nuclear explosive or dispersal device.

- It is conceivable that such people could be assembled and motivated to conduct a malevolent act involving SSNM.

- Although the possibility appears extremely low, if such a group should succeed in obtaining significant quantities of SSNM, a major civil disaster could result. Many thousands of casualties could result, for example, from the successful detonation of a nuclear explosive device and possibly hundreds from a plutonium dispersal device. Acts of sabotage could also create significant hazards but of a lesser order of magnitude.

- With or without a MOX fuel industry, large quantities of SSNM will exist in the U.S. in support of various DOD-related programs.

While the possibilities of illicit use of SSNM are judged to be remote, they must be considered and guarded against. These risks, however, should be viewed in light of other means of creating mass casualties, in some cases with far less difficulty, which have long existed but have never been utilized. Moreover, while the incidence of crime and terrorism, both in the U.S. and abroad, increased sharply in the 1960's, there is no substantial evidence that any individual or group has ever successfully attempted to exploit the weapons potential of SSNM for causing a civil disaster.

There is considerable uncertainty whether groups such as terrorists or organized criminals who might have the capability to acquire and utilize SSNM to cause mass casualties would desire to do so. In the past, terrorist groups have selected actions which seemed calculated to draw favorable attention of some segments of the population to their point of view, while the aim of organized criminals has been to acquire wealth. Malevolent use of SSNM would not appear to serve either of these purposes. Nevertheless, the possibility that such use might be attempted, even irrationally, cannot be dismissed.

An important question in designing a safeguards system to protect against external attack is the size of the potential attacking force. Acts by terrorist groups or criminals, whether accomplished covertly or by outright assault, have generally been performed by small groups. Participation by numbers in excess of 6 has been relatively rare, and by numbers in excess of 12 even rarer. While this experience cannot be projected precisely into the future, factors which tended in the past to keep criminal and terrorist groups small, principally fear of detection, would seem likely to continue.

3.0 CONSIDERATIONS IN DESIGNING A MOX SAFEGUARDS SYSTEM

In preparing this report, a variety of alternative safeguards systems and approaches was considered. It was concluded that a future MOX industry could be adequately protected under existing regulations along with certain upgrades of these regulations presently under consideration. In reaching this conclusion, a reference safeguards system was developed, assessed for its cost and adequacy, and then utilized as a point of departure for assessing other safeguards alternatives.

Two fundamental issues arose in assessing whether the safeguards measures considered would be effective in protecting the MOX industry:

- What level of protection and what degree of assurance regarding that protection are appropriate?

- Would there be technical, societal, commercial, or other practical constraints or uncertainties in implementing adequate safeguards?

In addressing the first of these issues, a policy determination was made that the same level of protection should be given to all compounds and blends of plutonium except those contained in irradiated fuel elements or high level wastes. The primary reason for establishing this policy was that all isotopes of plutonium are SSNM and these plutonium isotopes can be chemically separated from mixes and blends involving other elements. With respect to the irradiated fuel, it was judged that the intense radiation associated with these fuel elements (which exists with or without Pu recycle) would provide significant protection against theft. Similarly, nuclear radiation protects high-level wastes against theft, although not against sabotage.

The issues noted above were addressed from the standpoint that NRC's safeguards program for commercial licensees is part of a national safeguards structure introduced initially to protect defense-related SSNM. The structure includes three primary components: intelligence gathering, fixed site and transportation security, and recovery of lost material. For a wide-scale MOX fuel industry, only the second component, fixed site and transportation security, which involves physical security and materal control, would fall primarily within NRC's field of responsibility. The other two, intelligence and recovery operations, would remain the responsibility of other agencies such as the FBI, the National Security Council, DOE, and State and local law enforcement agencies. NRC collaborates with these other agencies in developing contingency plans for reacting to and dealing with theft or diversion, but does not participate in intelligence operations or physically take part in recovery operations.

Within this national framework for safeguards, NRC is the beneficiary of the intelligence collection capabilities developed by other agencies. Existing safeguards systems make use of but are, however, not dependent upon the timely collection of intelligence data. The safeguards for any future MOX industry would similarly make use of but not depend upon intelligence operations for their effectiveness. There are no requirements presently envisioned by the NRC to increase the collection of intelligence in order to safeguard a future MOX industry.*

*This does not mean that the FBI or local law enforcement agencies would not attempt to gather additional information if threats or rumors indicated that a nuclear facility might be attacked or sabotaged.

No specific threat was used in designing the reference safeguards system. Rather, advantage was taken of the fact that most aspects of a properly designed safeguards system, such as barriers, detection and alarm systems, measurement systems, and guard training can be designed to be relatively independent of the magnitude of the threat. Current DOD, DOE, and NRC safeguards systems emphasize redundancy and diversity to further reduce the sensitivity of safeguards designs to assumptions concerning threat levels and capabilities. The reference safeguards system design discussed in this document also uses this approach.

The NRC is currently upgrading the required safeguards performance levels for the licensed nuclear fuel industry and for nuclear reactors. Safeguards at these facilities will be designed to protect against (a) determined, violent assaults by small groups armed with automatic weapons and explosives, possibly assisted by an insider, and (b) internal conspiracies involving employees.

The self-contained capability of the reference safeguards system described in Chapter 5 is consistent with these upgraded threat requirements. Moreover, if the support of local law enforcement agencies is considered, the reference system can confidently safeguard against an even greater external threat.

In specifying a MOX safeguards system design, emphasis was placed on technical and operational options that are either available today or are expected to be available in the near future. This was done both for design conservatism and to ensure that the societal risks and burdens imposed by MOX industry safeguards could be readily definable. As examination of possible combinations of safeguards technologies progressed, it became apparent that a system which met the design threat with high confidence could be developed employing the existing regulatory base, including planned upgrades. Accordingly, the reference system was developed within the specific requirements described in 10 CFR Parts 70 and 73, supplemented by selected upgrades. The existing regulations require that licensees implement safeguards measures which include periodic material inventories, escorted shipments, physical barriers around materials, controlled access to materials, exit searches, onsite or escort guard forces, and communications to local law enforcement agencies. The upgrades to these baseline regulations, judged necessary to meet MOX industry safeguards performance needs, include personnel clearances for security force, operating, transportation and management personnel, improved guard training and capabilities, and the use in transportation of hardened transport vehicles with additional escort vehicles and guards.

In addition to upgraded regulations for the existing industry, the NRC is also considering an approach relying on a general set of performance criteria for the design and evaluation of licensee safeguards systems. These criteria would permit licensees to meet safeguards requirements by designing systems specifically for each site. This may or may not require that different sites have different mixes of safeguards system elements. As a consequence, the reference safeguards system developed in this study is considered as but one representative approach for meeting the upgraded regulatory requirements.

In order to specify the various subsystems which comprise the reference safeguards system, it was necessary to develop models of MOX industry reprocessing, fuel fabrication, and fuel assembly facilities, and of MOX assembly storage areas at reactors in sufficient detail to permit identification of appropriate safeguards hardware, personnel, and procedures. The resulting reference system, based on numerous supporting studies and analyses, was consistent with the safeguards requirements imposed by 10 CFR Parts 70 and 73. To assure a high confidence system, a generally conservative approach was adopted.

The reference safeguards system described in this document is intended to meet seven design objectives for fixed sites and three for transport. For fixed sites the objectives are:

(1) Ensure that only authorized personnel and materials are admitted into material access areas (MAA's) and vital areas (VA's).*

(2) Ensure that only authorized activities and conditions occur within protected areas, MAA's and VA's.

(3) Ensure that only authorized movement and placement of SSNM occur within MAA's.

(4) Ensure that only authorized and confirmed forms and amounts of SSNM are removed from MAA's.

(5) Ensure timely detection of unauthorized entry into protected areas.

(6) Ensure that the response to any unauthorized activity is timely, effective, and appropriate to the particular contingency.

(7) Ensure the presence of all SSNM in the plant by location and quantity.

The three design objectives for system performance during transportation are:

(1) Restrict access to and activity in the vicinity of transports.

(2) Prevent unauthorized entry into transports or unauthorized removal of SSNM from transports.

(3) Ensure that the response to any unauthorized attempt to enter vehicles and remove materials is timely, effective, and appropriate for the particular contingency.

4.0 MEASURES EMPLOYED IN THE REFERENCE SYSTEM

The reference system uses multiple and redundant sensor systems in parallel to detect intruders at the perimeter of fixed sites. Three independent but complementary types of sensors--seismic, microwave, and closed circuit television, each deployed in a clear zone between fences--were selected from among the various types available in order to achieve reliable detection capability.

*Material access areas are areas which contain special nuclear material. Vital areas are areas which contain material or equipment whose failure, destruction, or release could directly or indirectly endanger public health or safety by exposure to radiation.

As part of the fixed-site material control system, all personnel and material leaving an MAA would undergo a search for the presence of SSNM. A physical search or equipment for detecting the gamma radiation and neutrons emitted by isotopes of plutonium could perform this function. In this connection, studies conducted by NRC indicate that random employee searches utilizing highly sensitive hand-held devices, combined with fixed detectors employing a combination of neutron and gamma detection technologies, could, with high confidence, detect very small amounts of concealed (and even shielded) material before sizable quantities could be accumulated.

Studies also indicate that present material control methods and contemplated upgrades of these methods will ensure that diversion from, or the malevolent use of, MOX industry waste and scrap streams can be controlled by careful collection and radiation monitoring supplemented by random samplings from the streams. Specially marked and sealed containers would continue to be used in waste and scrap transport.

While the reference system is designed to protect fixed facilities against the threat of plutonium theft, it also provides protection against sabotage. Additional protection against acts of sabotage is inherent in the massive structures and certain other features required for health and safety reasons. For example, the portion of a plant used for storing or processing plutonium must be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods. Massive amounts of explosives would be required to breach these structures and disperse significant quantities of plutonium.

The safeguards measures required by the current regulatory base for protecting SSNM during transportation include escort forces, communications, vehicles that resist unauthorized entry, and arrangements for reaction forces from such sources as State police, highway patrols, and local law enforcement agencies. The reference system places primary reliance on a self-contained protection capability. Assuming that the escort guards carry the semi-automatic weapons now authorized by law, a shipment convoy could include from 6 to 12 guard/drivers,* including 2 armed drivers for the vehicle containing SSNM. The guards would ride in hardened escort vehicles, 2-3 guards per vehicle. Analysis indicates that this number could effectively deal with a substantial force of well-armed attackers.

As in the case of fixed-sites, the reference system measures designed to ward off attempts to steal plutonium from transport convoys also protect against attempts to release radiation by sabotaging shipments. The integrated container vehicles in which Pu would be shipped provide additional sabotage protection.

High-level waste from reprocessing plants is expected to be shipped as a vitreous solid in a cask built much like a spent fuel shipping cask. Radiological consequences of any attempt to sabotage a shipment and actually disperse radioactive material are judged to be sufficiently low and do not require additional physical protection measures.

*Within this range, escort numbers would be tailored to the particular route and expected conditions. Normally, numbers would approach the low end. For routes along which reenforcements were not readily available, or other adverse conditions existed, escort numbers could be increased.

A feature of particular importance in the reference system is the control of guard response involving the use of force. The fixed-site guard force is allowed sufficient time and flexibility to assure that their use of force is deliberate and required. The system includes perimeter features which would: (1) significantly delay the flight of employees detected with unauthorized SSNM in their possession; (2) promptly detect attempts at unauthorized entry; and (3) make certain that unauthorized entry at the perimeter requires such a degree of skill and determination as to preclude casual entry by nonviolent intruders. To give transport guards comparable time and flexibility, trucks containing SSNM would be hardened to resist penetration.

The reference system capital and annualized operating costs for the year 2000, summarized in Table ES.2, are based on NRC staff estimates and supporting studies. The capital costs, $159 million, are relatively low when compared to the billions invested for a MOX industry by the year 2000. The annualized safeguards costs of $141 million would add about 7% to the operating costs of MOX facilities and about 0.2% to the total consumer cost of MOX-generated electric power.

It was concluded that it would be easier to implement safeguards systems in future MOX facilities than in existing facilities now handling SSNM. Firstly, new facilities can be specifically designed to meet safeguards requirements. Secondly, the containment features of plutonium processing facilities required for health and safety reasons greatly simplify the problem of safeguarding the material.

In summary, no significant operational, health, safety or societal impediments to the implementation of the reference safeguards system were identified. Implementation of the reference safeguards system would not alter significantly the general character of the MOX industry or any of its facilities, and the added cost of safeguards would not be pivotal in assessing the impact of a MOX industry on the U. S. economy. Variation in assumptions concerning required protection levels and the costs of the various safeguard elements does not materially change this observation.

TABLE ES.2
SAFEGUARDS COSTS FOR MATURE MOX INDUSTRY IN THE YEAR 2000
(Millions of 1975 Dollars)

Element	Capital Costs	Annualized Operating Costs
Fuel Facilities		
Reprocessing	35.8	30.8
Fuel Fabrication	44.1	58.3
Fuel Assembly	8.8	11.5
Total, Fuel Facilities	88.7	100.6
Transportation System	51.7	35.8
Total MOX Fuel Cycle Industry	140.4	136.4
Reactors*	16.6	3.0
Added Regulation Costs	1.8	1.7
Total Safeguards Costs	158.8	141.1

*The only reactor safeguards costs included are those associated with the protection of unirradiated MOX fuel while stored at reactor sites.

5.0 ALTERNATIVE SAFEGUARDS OPTIONS

Five alternative safeguards options were also examined. In general, these measures offer the potential for improving overall safeguards performance or reducing the societal impacts attributable to safeguards. Each was examined from the standpoints of performance improvement, economic cost, and societal and industry impacts.

The first alternative considered was the use of Federal rather than private guard forces. In the Security Agency Study published by NRC in August 1976, the use of Federal guards instead of private guards for all facilities containing SSNM was analyzed in detail. The major conclusion reached was that guard force effectiveness is essentially independent of whether the force is Federally or privately employed. In general, it was determined that guard effectiveness depends primarily on personnel qualifications, particularly motivation and training, and that appropriate Federal regulations, guidelines, and implementation procedures influencing these factors can be applied with approximately equal effectiveness to both Federal and private guard forces. Based on these findings, the Security Agency Study concluded that there was no compelling reason to enact new legislation to establish a Federal force. No unique characteristic of the materials, facilities, or safeguards in a MOX industry has been identified that would alter this basic conclusion of the Security Agency Study.

A second alternative considered was to seek changes in State gun laws to permit future MOX industry civilian guards to possess automatic weapons, as a means of increasing guard force effectiveness or permitting a reduction in the number of guards. Existing information does not indicate that automatic weapons would provide guards with a measurable and generally reliable increase in effectiveness. Accordingly, it does not seem advisable to contemplate any reduction in the total number of guards as a consequence of any presumed benefits bestowed by automatic weapons.

The third alternative considered was to blend plutonium oxide with uranium oxide early in the fuel cycle so that only dilute mixtures of plutonium would be shipped between facilities. Blended plutonium compounds are muc more difficult to fabricate directly into an explosive device than pure PuO_2, and concentrations of 10% or less would require separation. The added difficulty of separating the blended materials and then constructing a nuclear explosive would give the recovery operations of law enforcement organizations additional days, perhaps weeks, in which to locate stolen material with hig assurance that a workable nuclear device had not yet been assembled. For directly useable PuO_2 blends, the comparable high assurance time is only a few hours. The additional amount of blended material (as compared to PuO_2) needed to manufacture a nuclear explosive would probably not significantly affect the chances of success of external attack and theft. It might, however, aid somewhat in detecting internal theft and diversion. Depending on the blend ratio adopted, annual costs of blending to the MOX industry in the year 2000 have been estimated at between $30 million and $50 million in 1975 dollars.

A fourth alternative was the collocation (placing at the same site) of facilities performing successive steps in the MOX fuel cycle. The most significant safeguards advantage would be the virtual elimination of pure PuO_2 from the transportation links. While pure PuO_2 is expected to represent only about 12% of the shipments of all plutonium mixes and compounds requiring safeguards, it is more attractive than MOX as a starting material for constructing an illicit nuclear explosive. It is thus strategically advantageous to restrict PuO_2 shipments. Collocation appears to offer modest cost savings to a MOX industry; but if a collocated facility consisted of only one reprocessing facility and one fabrication plant and either one of these facilities had an extended shutdown due to process breakdowns or accidents, either intersite transportation of PuO_2 would be required or significant economic penalties would be incurred by the companion facility. Another concern arises from a negative public perception toward decreased industrial competition as a result of collocation.

The final alternative safeguards option considered was the use of air transportation for the shipment of PuO_2 between reprocessing facilities and fabrication plants. Successful development of crash-resistant containers appears to make this technically and legally feasible and would virtually eliminate any hazard to public safety from plutonium dispersal in the event of a crash. This alternative, like collocation and blending, has the virtue of eliminating routine surface shipment of PuO_2. The costs for air transport would be higher than for the road transport it would replace, but not significantly so, the difference being estimated at $2.3 million per year in the year 2000.

6.0 SOCIETAL AND ECONOMIC IMPACTS

The reference safeguards system would introduce certain societal and economic impacts over and above those resulting from the safeguards required to protect existing nuclear commercial facilities. These impacts would result primarily from:

- The added measures and procedures introduced to protect nuclear fuel cycle facilities when MOX is used.

- The projected increase in both the number of fuel cycle facilities handling SSNM (approximately 20 additional facilities by the year 2000) and the corresponding increase in shipment of plutonium compounds among the facilities and to MOX-using reactors (about 2,400 shipments per year by the year 2000).

Examination indicates that the societal impacts of a MOX safeguards system would not be of a fundamentally new character. Instead, they would be primarily increments to impacts already imposed upon society by measures to protect comparable material under NRC, DOE, or DOD control. Moreover, the direct impacts are likely to be confined to a rather limited number of individuals, most of whom would be employees of the nuclear industry.

In analyzing societal and economic impacts, special attention was given to those areas of concern most frequently identified by critics of plutonium recycle and by other concerned citizens. These are categorized in the summary discussion which follows as impacts on civil liberties, existing institutions, the economic well-being of industry and the public, legal issues, and the physical environment. The severity of the impact in each area of concern was examined both for the safeguards measures of the reference system and for the alternative options considered.

6.1 Impacts of the Reference System

In the area of civil liberties, the impacts identified would affect relatively few people and represent primarily extensions of existing practice:

- Portal searches and inspections contemplated for nuclear plants raise the issues of invasion of the privacy and infringement of the Fourth Amendment rights of industry employees and visitors. Experience with existing SSNM facilities and other industries (particularly the millions of personal searches conducted each year at airports) suggests that the impact of these measures would amount only to a very small quantitative extension of existing practice.

- The proposed preemployment clearance program raises concerns about invasion of privacy and possible infringement of the First Amendment rights of would-be employees. Here again, precedents involving clearances required for jobs in government; the existing SSNM industry; and such private enterprises as banks, airlines, precious metal firms, pharmaceutical companies, and private guard service companies indicate that an NRC-mandated clearance program covering approximately 21,000 guards and reactor and fuel cycle personnel would be but a minor extension of existing practice. Impacts on the general public would be limited to answering questions asked by investigators regarding prospective employees.

- Surveillance of individuals or groups for intelligence collection, often cited as an example of an adverse impact which can accompany the introduction of a wide-scale MOX industry, is not among the safeguards measures being considered. Appropriate information-collection efforts are already routinely conducted by Federal and State agencies under numerous judicial and constitutional constraints. Introduction of a MOX industry and its safeguards would not in fact require any surveillance or intelligence collection beyond what is presently needed to protect comparable facilities and material. It would merely require that the information already being collected be screened for threats to the MOX industry.

- In the event of a theft of material, activities involved in recovery of missing materials could be expected to touch upon the lives of employees and many members of the public at large. Some people fear search procedures and intensive investigative efforts requiring waiver of search warrants, use of warrants lacking particularity provisions, and infringements of First Amendment rights. Recovery operations are not NRC's responsibility and not specifically a part of NRC's proposed safeguards system; nevertheless, a review was conducted of anticipated recovery actions. The results indicate that no operations are contemplated which would arbitrarily disregard existing laws or require illegal investigative practices or procedures. Future search and recovery operations for reprocessed plutonium would have no greater potential for impacting on civil liberties than the procedures presently used for other important recovery operations, especially such operations as would be used to recover stolen nuclear weapons or stolen SSNM from any of the presently licensed facilities.

Only a few potential impacts on existing institutions were identified and their effect appears to be minor:

- A preemployment clearance program might be viewed as inserting the Federal Government into the nuclear industry's hiring process. It is estimated that in the year 2000, a clearance program would be confined to about 21,000 security and fuel cycle facilities personnel. The Government would have no greater impact on these individuals than it already has on a far larger number of civilians who do such things as dispense narcotics, handle defense secrets, or conduct the numerous other commercial activities in which participation requires Federal approval.

- Surveillance for intelligence collection is not expected to result in a change in the roles and missions of existing agencies and institutions. Any "nuclear threat"-related activity would be routinely assimilated into ongoing investigative activities. NRC would continue to exchange information and coordinate with appropriate law enforcement agencies. Any surveillance conducted would be incidental to that already routinely performed in protection of comparable facilities and materials.

- If a quantity of plutonium were ever successfully diverted or stolen, recovery activities could require some short-term withholding from the public of critical items of information. This would be no different than the limitations on news releases currently invoked by law enforcement officials during investigations of major crimes such as kidnappings, political assassinations, and major bank robberies.

The economic burden caused by implementing the reference safeguards system appears to be minimal compared to other costs associated with a MOX industry and, with the exception of certain Federal regulatory costs, would be passed on directly to the final users of electricity.

- The estimated increment in annualized MOX industry costs in the year 2000 for implementing the reference safeguards system (or the possible options considered) ranges from $141 to 200 million per year (in 1975 dollars). This includes depreciation on the fixed investment for safeguards equipment, return on capital, equipment maintenance, and guard force salaries. Safeguards would thus amount to seven to ten percent of the $2.1 billion yearly cost projected for the MOX industry in the year 2000.

- In terms of cost to the consumer of electrical power, the reference safeguards system would increase the cost to the average consumer of electricity generated with MOX fuel by 0.2% (approximately 0.1 mill per kWh) in the year 2000.

- Indirect annual costs to cover the necessary Federal regulatory activities for MOX industry safeguards in the year 2000 are estimated to be about $1.7 million in 1975 dollars.

- While no firm cost estimates have been made of liability insurance premiums to be paid by industry to cover possible third-party injuries resulting from guard force actions, these should not differ substantially from the existing costs to other industries for guard force liability coverage.

In the area of legal impacts, i.e., impacts not covered by present laws, statutes, authorities, etc., little is anticipated of a substantial nature.

- Personnel clearance programs are within the present statutory authority of NRC, and could be imposed on present NRC licensees independent of any MOX decision.

- While the use of deadly force by MOX industry private guards would be restricted by State laws to certain legally justifiable situations, the same restriction is imposed on all other civilian guard forces.

- No new legal problems are anticipated as a result of any necessary recovery operations. Any damage to the private property of innocent members of the public as the result of recovery operations appears amenable to compensation via existing laws and administrative practices.

In the area of the physical environment, the reference safeguards system is not expected to have significant impact.

6.2 Impacts of Alternative Safeguards Options

The alternative safeguards measures considered (i.e., use of Federal guards, possession of automatic weapons, blending, collocation, and air transportation) could, as noted below, introduce some societal impacts, but none is considered so significant as to seriously influence a MOX decision.

Federal Guard Force

- The use of a Federal guard force with training equal to that of private guards should have the same impact on the civil liberties of employees and the general public as would continued use of private guards.

- In the institutional area, use of Federal guards would represent an extension of Federal responsibility into the activities of private industry. This would not establish a precedent, however, given the past use of Federal guards at contractor-operated DOE-owned facilities and the expedient use of Federal marshals on commercial airlines. On the other hand, it would lead to an additional Federal bureaucracy.

- Industry impacts result if Federal guard force supervisors would find it necessary to override industry management decisions during an emergency situation.

- Should automatic weapons ever be required, it may be legally easier to empower Federal guards than private guards to use such weapons.

Possession and Use of Automatic Weapons

- Use of automatic weapons at civilian facilities not handling Federally-owned material is presently illegal in most states and could only be permitted via new legislation. If Federal regulations were to require MOX licensee guards to possess automatic weapons, an institutional problem would result unless new State legislation were adopted.

Blending

- No civil liberties impacts are foreseen from blending.

- Institutional issues might arise due to increased Government involvement in process decisions, normally the province of private industry. Such involvement is, however, not unusual in a highly regulated industry. Precedents, such as regulations forbidding the shipment of plutonium nitrate solution and liquid wastes, already exist.

- It appears that blending can be required under NRC's present statutory authority.

- Economic impacts take the form of production cost increases which would vary with the blend ratio involved. An estimated blending cost increment of $30 to $50 million would be added to the annualized safeguards costs. This represents an increase of between 21 to 35 percent to the reference safeguard system annualized cost.

Collocation

- Collocation would lead to additional Government involvement in, and an increase in the complexity of, industry siting decisions.

- Safeguards costs might be reduced slightly by collocation. The number of fixed-site guards for the industry as a whole would, for example, be somewhat lower due to economies of scale, reduction in the number of sites, and elimination of some transportation guard requirements.

- Legal issues, most of which can lend themselves to reasonable solutions, consist of selection of an equitable transition path to a collocated industry, maintenance of competition within the industry, and grandfathering of existing facilities.

Air Transport. The societal impact of requiring the air transportation of PuO_2 (assuming that the public safety issue is resolved by the use of crash-proof containers) would be mainly in the economic area, both the initial investment cost and the annual operating cost. Ultimate cost impact on the consumer of electricity would not differ significantly from that of a ground transportation system.